CONSIDERATIONS UPON MINING SCIENTIFIC RESEARCH ACTIVITIES IN REVISTA MINELOR – MINING REVUE

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Introduction

The extraction and exploitation of mineral solid raw materials in Romania is done from ancient times and the variety and importance of mineral resources has imposed mining to become a habit for over 2,000 years in this European region.

In time, mining has provided the Romanian countries important quantities of minerals and had a crucial contribution to the country technical and economic progress.

World and national statistics show that Romanian mining has gradually developed as far as the production of metal minerals, non-minerals and various fossil fuels is concerned.

The evolution and technical knowledge spreading regarding mining was supported by schools and technical literature where the mining publications had a special role.

Various mining publications were published in Romania and delivered to the public and to production specialists, researchers, designing and education professionals such as:

Romanian Mining Annals – 1918-1948
Mining and Metallurgy – 1922-1927
Mining – 1926-1948
Mining Revue – 1950-present

Every publication above has reflected the development and the achievements of Romanian mining. The magazines have promoted the new findings, have enabled the specialists from production, research and education to present their opinions and achievements, have hosted the debates of some important mining problems, and have reflected the development of worldwide mining emphasizing Romanian mining.

Considering that the current issue celebrates 70 years from the moment when the first number of Mining Revue was published, I will try to review Romanian mining scientific research concerns and achievements presented in the more than 850 issues, containing over 6,000 articles.

The research activity presented by the Revista Minelor – Mining Revue

In the 20th century, mining recorded its most important development. The increasing production pace, the growth in number and size of the mining enterprises, the increase of exploitation depth, the introduction of large scale mechanization and the necessity of providing better work conditions has brought to mining science and practice a series of more complex problems compared to the ones in the past.

At the end of the 19th century and the beginning of the 20th century, a spectacular scientific and technical leap in all activity domains was recorded. The governments intervened in the funding and the management of scientific research, in publishing of technical and scientific literature into various specialized magazines, in supporting the research and the scientists through organizing and participation to national and international scientific conferences.

The establishing of Nobel Prize award, in 1901, stimulated the competition between researchers, attracted for research support, private funds beside the government finances, hastened the endowment of laboratories with new equipment based on the latest technical inventions.

The second industrial revolution took place in line with the period advances and had as main outlines: application into practice of the scientific and technical innovations, large scale use of the new energy sources, capital concentration, work rationalization, resource increase, more rational use of common, precious and rare metals, etc.

The second industrial revolution has transformed Europe in the most important industrial point of the world through the dynamic of the old and new production branches and the spread of the industrialization process, in various forms and stages, through the entire continent.

In that period substantial progresses in the modernization of some of the main components of mining activities were recorded.

An important factor was the introduction in mining of some new sources of energy, which replaced physical, human or animal force: steam energy, electric energy, pneumatic energy, etc.

There are changes in the digging and rock / minerals dislocation techniques, in using on large scale the works with hewing hammers, drillers and explosives.

The exploitation methods are adapted to the deposit conditions. Therefore, in salt exploitations the chambers are dimensioned, designed and

exploited through the method of trapeze chambers, which gave a better safety and increased depth for mining works. They also experimented and adopted the salt exploitation through static dissolution in underground basins.

The coal industry in Valea Jiului recorded important achievements where various exploitation methods specific for thin and average layers but also for thick layers of coal were employed. Thin layers were exploited by leading the pressure through crumbling, while thick layers were exploited by dry or hydraulic embankment for pressure lead. In some situations, it is used the mixed exploitation with both embankment and crumbling.

In the mines in Anina two exploitation methods were used: the main thick layer was exploited through horizontal slices completely embanked while the thin layers were exploited through the method of inverted steps, without embankment.

The opening of the mines through vertical or inclined shafts is used increasingly more and the underground and surface transportation is improved.

Gradually, the pulleys are replaced by winches or high capacity extraction machines provided with engines operated by steam or electric energy. For the horizontal transportation there are used gradually electric, Diesel, compressed air or vapour engines. For the uneven field transportation, the cableways are used more and more. All the above enabled the manipulation of a large quantity of materials and minerals.

The compressed air and electric energy is introduced for the underground illumination and for ventilation and water evacuation.

Important progresses are found also in mineral processing and preparation. Even before World War I, coal washing installations were built in Lupeni and Steierdorf-Anina, before they were used in various economic fields.

In the metallic ore processing field there are advances in the operations of crushing, washing, separation, etc. Therefore, the old stamps are modernized by increasing the weight of the arrow, introducing the Californian stamps which had higher force and the impact frequency. Later a new segregation method is introduced and modern processing factories are built in Gurabarza and Maramureș.

In this context, the specialists in the mining industry aimed to use the natural sciences, the laws of physics, chemistry and mechanics in order to understand, explain and control the events met in production. Therefore, it appears worldwide the need to increase the level of applied scientific research followed by the design of technical objects and objectives.

In Romania, scientific research was used in mining only after World War I. At the time, there were no research-design institutes specialized in the extraction field, but there were laboratories, within the Polytechnic Schools in Bucharest and Timișoara and other large universities, where various problems of mining could be analysed and some solutions could be provided.

Also, the large mining societies, such as "Cărbunele-Petroșani" and "Mica-Brad" had research laboratories and asked their specialists to find technical solutions for the problems found in practice. One of the most important problems was to determine the gold content of the ore exploited in surface or underground. Those determinations were done most of the time with the rudimentary tools the workers had.

The need to improve the processing operations for mineral ores and to know in detail the minerals from the new exploitation areas has imposed new investigation and control techniques, therefore in 1938 there was built in Brad a new research and analysis laboratory with the purposes of: research for improving the processing technologies, geologic research, microscopic research on thin and polished layers done on rock and mineral samples, chemical analysis on minerals, metals, oils and lubricants, docimasia analysis, etc.

Furthermore, for poor pyrites processing there was built a leaching cyanidation installation, while for barren storage from the processing installations (stamps and flotation) there were built tailing dumps.

In Transylvanian gold mining, Californian stamps had a large use after World War II, and they were gradually replaced later by ball mills.

In 1937 the ore production extracted and processed from the mines of Apuseni Mountains is tripled compared to the 1928 production, therefore we have the largest noble metal quantity ever achieved by an European province – 5465 kg of gold and 25,645 kg of silver.

In salt extraction, during the two world wars, the Romanian Government nationalized and modernized the salt mines. First, the number of salt mines decreased, some of them that were unprofitable being closed, for example Ocna Sibiului, Turda and Coșteiu.

The operating ones had their extractive installations modernized and systematized, raising the productivity according to the consumption demands.

All the Romanian salt mines replaced the old salt cutting methods, using the iron hammers and wedges, with the explosive techniques and cutting machines. The introduction of explosive works had a major contribution in increasing work productivity but had as a negative effect the decrease of the stability degree of the walls and chamber floors. The cutting machines were used in opening works but also for the fact salt extraction.

In ore preparation, the progress was initiated in 1928 when most of the national preparation installations are modernized. This was determined mostly by the introduction of flotation which revolutionized the ore mining in the entire world.

During 1928 and 1933 all the preparation installations for non-ferrous and gold ores have flotation installations or others which use flotation along other procedures.

Most of the new technologies in mining were the result of imports, but in some cases there were also results of the researches done by Romanian specialists.

The mining research was mostly applicative and aimed to modernize the preparation possibilities of various ores and coal sorts from Romania. In the same time there was a small number of researches with theoretical objectives.

Academician Huber Panu had a crucial contribution to settling the basis of the flotation theory, which was acknowledged worldwide. Also, the same author settled, in 1940, a general unitary theory for the gravitational sorting and concentration processes.

Among the applicative works published let's mention the studies done under the auspices of Professor Gh. Vanci regarding the cyanidation of some of the gold ores in Romania, leading to important applied conclusions.

All the mining areas registered modernization tendencies, introduction of new techniques, mostly as a result of local initiatives, not by means of a general improvement program.

The need of training specialists in Romania for various technical branches had lead, in 1920, to the transformation of the National School for Bridges and Roads in Bucharest into a Polytechnic School and to the foundation of the Polytechnic School in Timișoara with two sections – Mining and Metallurgy, which became in 1938 the Faculty of Mining and Metallurgy and had as an objective the training of mining engineers.

An important role in supporting the mining activity had displayed the "Association of Engineers and Technicians in the Mining Industry", created in 1918 by:

- The four congresses, in 1921, 1922, 1931, and 1939, when mining technical and technology issues, work organization and norming issues, economic aspects of the mining activity were debated, etc.;
- The association sections, which included the high education mining specialists, from different mining areas
- Magazine "Romanian Mining Annals" (1918-1946), which reflected the path followed by the Romanian mining between the two world wars.

In the same period there were also other magazines such as "Mining and Metallurgy" (1922-1927) and "Miniera" (1926-1948). Also, the mining technical literature developed, sustaining the theory and practical knowledge of the progress in worldwide and national mining.

For example, based on various studies done on the auriferous regions from the Apuseni Mountains by various researchers, in 1940 T. Ghițulescu and M. Socolescu published the geological-mining monograph of the Metaliferi Mountains named "Etude Geologique et miniere des Monts Metaliferes", monograph used by multiple generations of geologists and mining engineers who activated in the Apuseni Mountains.

During the two world wars, most of the Romanian mines faced multiple problems such as: the maintenance of the manual works, both in hewing and transportation; the use of traditional tools and the lack of mechanical installations; the high number of accidents and professional diseases, etc.

The short period between the two world wars, the historical conflicts in the past and present, the economic crisis made the mining production to advance in bounces with frequent periods of recovery or failure.

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During the period 1948-1949, Romania hugely developed secondary and higher technical education in order to meet the demands for technical specialists in industry, while facing the technical issues related to industrialization; the country institutionalized the scientific research and the design of technical objectives and products.

The first activities of mining research and design had been organized since 1949 in the old Bucharest Industrial Design Institute.

Together with the foundation of ministries on industrial branches, new development institutes were organized. Therefore, in 1950, Bucharest Mining and Metallurgy Research and Design Institute was founded

The activity goals of the institute, described in CD no. 968/1950, article 12, were:

- Technical and economic research in the fields of mining, preparation and metallurgy;
- Designing technical objects in mining, preparation, non-ferrous metallurgy;
- Specialized technical assistance for field enterprises;
- Specialized worker formation.

In the summer of 1951 two mining research and design institutes, ICEMIN and IPROMIN, which operated in Bucharest until 1973, were founded.

In 1974 the mining research and design institutes for the specific mining ores in Baia Mare, Cluj, Deva, Petroșani, Craiova and Bucharest were founded.

After 1960 the organization of the research and design institutes was regulated and the scientific research in high education became mandatory.

The research financing is done 90% through economic contracts with production units who had to assume and implement the results obtained to the production field.

Only 10% of the institutes' financing was done directly by the Government or by the funds of the National Council for Science and Technology, for a series of general interest complex themes or for fundamental research.

The higher education scientific research was fundamental or applicative and was mostly done by contracts with production units.

The entire research activity was led by research plans, framed for five years period, detailed yearly, and where were stated along the research-development themes also the material and human resources given for their accomplishment.

In order to enhance the contribution of research and development to the economic and social progress of Romania, they developed, under the auspices of the National Council for Science and Technology, beginning with 1969, yearly plans for the economic and social capitalization of the results of research and development, which were correlated to the current research and development plans, together with the plans to introduce new techniques for improving the quality of the existing ones.

The mining scientific research activity had in this type of management important results at regional and national level.

"The Research Station for Mining Safety" was founded in 1949 in Petroșani, having the level of a branch institute, including research sections and laboratories for challenges regarding mining ventilation, explosives, mining gas, explosive powders, technical prevention and controlling methane and coal powder eruptions, mining fires, mining installations testing and verifications considering the operation safety. In order to combat the influence of the silicogen powder there were organized pneumocystis laboratories in the main mining basins in Romania.

The development of the scientific research was possible because a sufficient number of young engineers of various qualifications collaborated, as a consequence of the fact that, through the higher education reform in 1948, the high education technical institutes multiplied and were organized to train engineers from different fields, needed for the national economy.

The engineers and researches in the fields of mining and ore preparation published their technic-scientific and fundamental research works in "Revista Minelor – Mining Revue", part of the Mining Ministry and of the National Council of Engineers and Technicians, in the Academy magazines, in the publications of the research institutes and also in the scientific papers of the high education institutes.

We observe that "Revista Minelor" was a field of debates and opinions for getting the best scientific, technical and economic solutions for the problems faced by the research, design and production activities in the Romanian mining field and worldwide.

The scientific research activity in the mining higher education and in the research-designing institutes took place based on five year or one year research plans, with the aim to engage the entire scientific potential in solving major problems regarding the development of the raw materials, minerals and energy base of the country and the modernization of the Romanian mining extraction industry.

Among the research works approached, considering the studied themes, the scientific research done by research, design and production specialists together with the professors from the high education institutes has included generally all the development and modernization issues from the mining industry in Romania.

The results of most research done had their application in production, considering the requirements of the developing mining industry.

Therefore, in the field of capitalization and rational exploitation of the mineral ore deposits, for the enlargement of the raw materials base there were done studies an research regarding: the exploitation of the safe pillars of the social-industrial objectives from the mining area of Valea Jiului and from some lignite areas in Romania; the underground exploitation of the bituminous shales from Anina; the optimization of the extraction technologies for the copper ore from the Apuseni Mountains open pits; the exploitation of the outcrop areas of the black coal deposits from the Valea Jiului area; mineral-petrographic studies for new deposits regarding their economic capitalization; etc.

Among the research on the design processes of new methods and exploitation techniques for mineral ores: the exploitation of mineral deposits from the area Ghelari-Teliuc, Deva, Baia de Arieș, Șuior, Bălan and from other mining areas, through the development of high efficiency methods regarding the undergrowth extraction, replacing the current extraction technologies for coal from the chamber works for thick black coal deposits with new ones by using extraction cropper machines; the design and operation of lignite from hard and very hard to extract deposits regarding the hydro-geologic conditions.

Combining the fundamental and the applicative research in engineering, the geotechnical studies and research referred to: sizing the support equipment for the horizontal and vertical mining works, considering the increase of the exploitation depth for the coal deposits in Valea Jiului, also the lignite deposits from the areas Câmpulung, Motru, Mehedinți and Horezu, regarding the difficult hydro-geologic conditions; studying the physical-mechanic and rheological characteristics of the rocks; the protection of the mining underground works from the seismic actions of explosions in open pits from Călimani and Roșia Poieni; studies regarding the work slope stability and waste dumps from the large lignite open pits from the Oltenia area and from the small open pits of the Valea Jiului area.

The development of the mining industry is closely related to the conception, design and construction of mining machines, tools and installations, suitable for the deposit conditions, which to mainly influence the intensive mechanization of the technologic processes, the increase of production and work efficiency. For example, we have achievements in constructing underground work machines, both for lignite and for black coal deposits, whose cutting parts were conceived and designed by specialists and professors from Petroșani Mining Institute, the drilling mobile installations and the self-unloading silo wagons, contributing to the increase of digging speed for the mining works, etc.

Concerning the issues of increasing the automation degree and of the introduction of the most modern methods for automatic command of the production processes, we mention the research and achievements regarding: the automation of the mining electro-mechanic installations and the microprocessor operation of industrial processes in the mines from the Valea Jiului area; the command of the work process in the rotor excavators from the lignite open pits; the automation of the mining electro-mechanic installations, etc.

The research done by the research-design specialists has an important role here regarding the design and the dimensioning of the optimal supply networks with electric energy for some coal and ore mines, regarding the modernization of flameproof construction mechanisms, through the cooperation they had with specialists from the machine construction factories, etc.

Regarding the preparation domain, there are researches on increasing the production of the coking coal by reducing the coal loss in the sterile slam from the Valea Jiului preparation plants and on the capitalization methods for coal waste, but also the scientific investigations related to the preparation methods for ores with lower metal contents from Moldova Nouă and Roșia Poieni.

The economic efficiency of the production activity is strongly related to the consumption reduction of materials and energy, to the increase of the exploitation reliability for machines and installations. In this field there were long term studies and researches regarding: the stability of the underground mining works in the Valea Jiului area considering the decrease of the material consumption and maintenance expenses; construction developments to the mechanized support equipment in the work chambers by reducing the metal consumption; energy result studies and methods to decrease the energy consumption in the economic units from Valea Jiului area, but from other mining units in Romania.

The scientific organization of production and work, the development of design methods by applying methods of mathematic-economic modelling represented a constant concern of specialists from the research institutes and high education, who aimed their studies in this direction. Selectively, among the latest research done, we mention the ones related to the scheduling and

observing the production in the mines of the Valea Jiului and Baia Mare areas; the organization of technologic processes in the mechanized complex work fronts from the black coal and lignite mines; the establishment of the optimal production capacities of some mines; correlation studies of some geologic-mining factors and techniques regarding the rational exploitation of lignite deposits from the mining areas Horezu, Motru and others.

Within the research methods new ways which led to important results used currently worldwide by scientists and technicians were introduced. We underline some directions where the fundamental interdisciplinary research, done by mixed groups – production specialists, researchers and high education professors – had an essential contribution:

- The use of photogrammetry in the mining production activity, for the evaluation of excavation volumes and use of mining pressure phenomena;
- The mining works execution leading with the help of the laser;
- The use of ferro fluids in the processes of preparation for mining ores;
- The mathematic modelling of methane gas releases from the coal mines in Valea Jiului area;
- The use of mathematic modern methods in studying the vibrations of the machine parts of mining installations;
- The liquefaction of coal in order to obtain superior fuels;
- The use of calculation methods for continuous deformable mechanic environments in studying the mining pressure phenomena, for sizing the support of the mining works;
- The use of mathematic modelling methods in studying the strain conditions for the open pit and underground mining works, etc.

The geologic research and especially the geo-physics domain extended, being systematized all over the country, using modern tools and mechanisms. From simple geo-physics prospects it moved to complex geo-physics procedures, using multiple methods of investigation (magnometric, electro-metric, gravimetric, seismometric).

Due to the new geo-physics methods of investigation, important filonian deposits in eruptive formations but also the discovery of new deposits with poor copper content, type "porphyry copper" at Roșia-Poieni, Bucureşci-Rovina and Bucium-Tarnița in the Apuseni Mountains were discovered.

In the field of setting the optimum place for the exploitations they elaborated systematizing studies, on basins, specifying the mining fields with the aim of reconstruction or amplification, for the exploitation in open pits or undergrounds, aiming the concentration of the production in high capacity units. Considering the great technic and economic advantages the use of modern installations in open pit exploitation have, this exploitation method was extended as much as possible where the natural conditions were favourable (Căpuș, Teliuc, Rovinari, Căpeni, etc).

Considering the opening works, for deep high capacity coal mines opening in Valea Jiului, they developed schemes with twin central wells and flank ventilation wells, split into great floors of 150-200m and with main opening works placed in barren (Uricani, Livezeni, Bărbăteni, Lonea). In the lignite mines, where the layers have small slopes and are generally place near the surface, the opening solutions were adapted to the deposit conditions, using the option of concrete galleries placed in the layer, simple or twins, with yearly mine productions of 800-1500 thousand tons. For the reconstruction and modernizations of salt mines it was used the opening system, applied recently in other countries, with spiral slope plans and high capacity truck transportation.

For the dislocation and cutting works there were developed thermo-resistant explosives, high safety explosives and also explosives based on ammonium nitrate with diesel fuel, whose successfully experimentation lead to the expansion of their use. There was developed the technique of millisecond explosion. There were experimented and used on large scale various modern schemes for the placement of explosive holes, for example the use of central leading unloaded holes, the explosion on deep holes and others. Regarding the mechanization of the cutting operations, for coal there were introduced the advance and front work mining machines, the rotation perforation expanded especially in the places with explosion works, much faster than the percussion works. For salt cutting there were introduced modern perforation carts with hydraulic transmissions, while for other ores the perforation with pneumatic support and water injection got generalized, suitable to our deposits.

Regarding the main mining works, they used the modern technique and also original technical solutions. Therefore, for well drilling in normal conditions it is used the sliding formwork and poured concrete, the bucket material loading being mechanized, for well drilling in sand conditions the freezing is used, the reinforced concrete doing the ultimate support of the well, unlike other countries. For most wells, the course through the wet sand conditions was done with a special cutting tool,

developed in Romania. Also, there was developed a technique of waterproofing the wells using bentonite. Lately there was experienced the drilling of wells of larger diameters.

Regarding the advancing works, they developed the technique of fast forwarding, using the advancing mining machines both for black coal and lignite deposits. In drilling the main holes in barren or hard rocks, we get results of 250-350m monthly advance, including the support and other necessary arrangements.

For drilling the climbs in the ore mines there were introduced and used on large scale the mechanic platforms, while for coal mines, in order to quicken the climbing drills there were used the deep large diameter exploding holes.

In the exploitation methods field, for lignite mines on small slopes there was often used the long front work exploitation method, in retreat; the use of this method due to favourable deposit conditions – with soft rocks nearby (compared to the black coal mines) – requiring the introduction of individual metal support.

The exploitation method with front works for the superior coal deposits from Valea Jiului evolved due to the improvement of the used tools. From the wooden support of mining front works, where the cutting was done by explosives, it was developed the cutting with mining machines, with individual metallic pillars with hydraulic operation. Where the natural conditions permitted, the method evolved until the overall mechanization of the mining works by mining machine cutting and supporting the front with mechanized complexes. The chamber works were only used as exploitation method in areas where the mining front works couldn't be used.

Through the hydraulic support, first with individual pump, then with central pump and articulated beams, progress resulted in the exploitation method with horizontal slices and transversal front work in the layer 3 from Valea Jiului. The best results were obtained by using the artificial ceiling of wire mesh on cable strands.

The high technical level and the progresses in Romania in the exploitation methods for thick coal layers have influenced the organization in Petroșani in 1966 by the U.N., an international symposium with the topic "The exploitation of thick coal layers".

Due to the multiple issues of the developing mining industry and the special results obtained by the Romanian research and design in this field of study, after 1965 they organized National Conferences for mining, while, as a recognition of the progress of Romanian mining industry, in 1972, in Bucharest, the 7th World Mining Congress was organized, with the participation of more than 2,000 mining specialists from more than 50 countries in the world.

With the organization of this prestigious world science exhibition Romania contributed with specialists from the Mining Ministry, research institutes in the field and especially from Petroșani Mining Institute, with the presence of Professor Ștefan Covaci, member of the International Mining Committee and president of the Romanian Organization Committee.

In the pages of "Revista Minelor" we could find plenty of information on the event's progress and the issues debated.

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Together with the discovery of the lignite deposits in Oltenia the issue of finding the most efficient method for their exploitation, considering their low level caloric power came out.

In time, they perfected, for the first time in Romania, the open pit mining of coal for Oltenia deposits. For years, they experimented various machines and tools in order to establish the most suitable technologic methods to be applied to the lignite open pits. The alternative chosen was to use the rotor excavators with cutting cups, belt conveyors and mining machines, assembled into a continuous flux technology, used as exploitation method with the transportation of the dump to internal or external tailings.

An important role in the accomplishment of the open pits design for various mining perimeters in Oltenia was the one of the Mining Research and Design Institute in Craiova and the Mining Institute from Petroșani, through the Department of Mining Exploitations. Its activity and the technic-economic results obtained demonstrated the reliability of the solutions founded and implemented to production.

In the lignite mines, in the past years, superior results were obtained through the introduction of the stepping support within the complex of drum combines, which allowed the expansion of the extraction field of a front up to 800-1000m (compared to 200-350m previously) with monthly advance speed of 60-100m. Through this implementation the mine framework was reduced and the preparation workload diminished.

For the ore mines the aim was to expand the exploitation methods with high efficiency, adapting them to the geologic and mining conditions of the

veins, so there was implemented the exploitation method for storage with inclined winds, the exploitation method with deep holes undergrowth and a series of combined exploitation methods.

An important achievement was the implementation of the horizontal front work with metal support pillars, for the exploitation of ore deposits (Baia de Arieș and Deva).

In many situations the ascending exploitation method with manual embankment was abandoned, in favour of storage exploitation methods, with crumbling undergrowth and ascending exploitation with hydraulic embankment in different versions given by the deposit conditions. Therefore, the advantage of the high efficiency exploitation methods led to their use in 85% cases until 1980.

For the surface loading of ores, the implemented technique was the extraction with explosives loaded in boreholes and loading the un-rocked material with the bucket wheel excavators and truck transportation. The activity from the Teliuc and Căpuș open pits served as valuable experience, used later in the activity of other open pits from Romania and for the opening of the bigger open pits in Călimani, Roșia Poieni and Moldova Nouă.

A valuable achievement was the use of the Romanian machine construction industry of the installations needed for the big open pits, consisting in: drilling installations F.C.-60 and F.C.-250, excavators with the bucket capacity of 2.8 and 8 m^3, and high capacity trucks of 50 and 100 tons.

Various deposit conditions and the fact that the Romanian deposits have small sizes forced the specialists to find solutions for every deposit, which has cumbered the implementation of a general method of exploitation and typified mechanization.

For salt mines, by implementing the exploitation method with small chambers and square pillars, called "the Canadian method", there was implemented a modern drilling, loading and transport technology, therefore the exploitation is done to the highest level, obtaining superior technic and economic values. For the exploitation method with small chambers and square pillars, the chamber height is 8m, the width is 16m, and safety pillars have the dimensions 14x14m, while the ceiling thickness between two horizons is 8m. The work technology is the following: in the front, the mining machine cuts a path on the hearth level with the depth of 1.8m, while the front is drilled by the machine, the holes having the distance of 0.9 – 1.0m between each other, with the depth of 1.8m. The used explosive is astral or ammonium nitrate with diesel fuel. The explosion is done electrically, using millisecond staples with 10 delaying steps. After the front is fired, it is ventilated for about 1.5-2 hours, afterwards the chamber ceiling and walls are furnaced.

The resulted oversized are broken manually, with hammers or are exploded. The resulted salt is loaded by a bucked wheel excavator or by a loader to trucks which transport the production to a collecting point or up to surface in the preparation plant.

In the preparation plant the salt is crushed, grinded and sorted on sizes and categories, and after it is treated with anticaking substances, packed in bags or delivered bulk, considering the needs of the internal or external beneficiaries.

The exploitation method with small chambers and square pillars is used in many salt mines and has the following advantages: high extraction coefficient, better access to work horizons and the avoidance of the barren material from the salt mass.

In 1950 the salt mines have also applied an exploitation method of the salt in the solution, using the Romanian patent of engineer A. Dima, by surface drilled boreholes, or underground by continuous column elevation using isolating fluid from oil products. This method enables the exploitation of diapirous rocks up to 2000m deep, unachievable depths for the exploitation of solid salt. Today, the method is applied to multiple exploitations from our countries (Ocna Mureș, Ocnele Mari, Tg. Ocna, Cacica, etc.).

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For the gallery support, beside the use of concrete galleries and the ones with brick ring support – instead of the reinforced concrete prefabs which are too heavy and breakable, there were other progresses with the science advancement. Therefore, in areas with high pressures and concentrations, it was widely used the sliding support of laminates with bell profile. For the ore mines it expanded the use of anchored gunite support with wire mesh and concrete crack and mixed support.

For transportation, to support the large production capacities of coal, for front works it is used the scraper conveyors with the length of 100-200m, armoured and high flow, fabricated in Romania. The general transportation in lignite open pits and to surface in underground mines towards the preparation factories is done by belt conveyors.

For high depth mines, with front works of lower productions, the transportation of production was organized with trolleys towards collector wells, from here the materials is carried by conveyor belts towards the main transportation belt which supplies the loading silo of the skip placed at the bottom of the well.

For the extraction, in some mines, there were introduced modern multicable machines (Aninoasa, Dâlja, Petrila).

For ore mines, they organized modern surface sorting and used, for long distance mining and surface transportation, trolleys type Gremby with 6-7 tonnes capacity.

For water handling, an important achievement was the perfecting of the studs drying technique, which was preventing the normal exploitation in lignite mines.

For mining ventilation and work security there were done major improvements. Therefore, in coal mining, the use of big axial fans was extended, for ores there was widely used the main and secondary ventilation with fans. For methane handling, beside the current devices which indicate the presence of methane, there were introduced centralized installations for methane detection and gas meters; also, it was introduced the pre-degassing method for layers. In handling the explosive dust, there was used the water layer injection at high pressure, the water drill and the slattering. To prevent diseases like silicosis, it is used the wet drilling, water splashing, worker medical control, rotation of workers in work fronts, etc. For underground lighting, the gas lamp which could generate accidents was replaced by the electric lamp with accumulator and the fluorescent illumination, also the electric and electro-pneumatic illumination was extended.

In the fields of mechanization, automation and energy saving a large activity of design, manufacturing, experimenting and perfecting for various mining machines and installations took place. Most of the underground installations were fabricated in Romania (perforators, work front hammers, scraper conveyors, scrapers, belts, pushers, loading machines, etc.). Also, most of the preparation installations were built in Romania.

As we can see above, an important support for the mechanization of the production processes in mines and open pits was given by the national machine construction industry. Actually, Romania created a mining machines construction industry. Being a country with various resources and difficult deposit conditions, Romania had to prepare a large range of machines and installations. Step by step, as the machine construction industry and the technical level improved, there were introduced installations such as mining locomotives, simple hydraulic pillars, drillers but also loading machines with silos on wheels, rotor excavators with the capacity of 1800 m^3/h, work front mechanized machines and advance combines.

Since for the most mining activities, especially for the ones connected to the front and support works, the main element is the pressure events which appear underground, in areas where the rock mechanics was not known enough, there was introduced the mining research method with the use of experimental work fronts, where the experiments are done at industrial scale. The research revealed various data regarding the mechanic properties of mineral substances and also data regarding their behaviour within the mining exploitations in various excavation conditions. There were obtained important results for the lignite deposits, where no previous data existed. Also, there were given information regarding the pressure behaviour in thick coal layers of high slope, and for salt deposits. The team of professors and specialists from the "Rock mechanics" laboratory in the University of Petroşani had an important role for this research.

During 1970-2000 the technical-scientific literature in the mining field was heavily enriched. Within the departments from the Petroşani Mining Institute there were elaborated numerous Ph.D. thesis in the field of ore deposits exploitation and capitalization, mining and preparation plants mechanization and automation, mining activity design and organization, etc.

For the needs of the specialists and researchers in the field, a group coordinated by Professor Aron Popa and including more than 50 production, research and education specialists has elaborated, between 1983 and 1985, "The Mining Engineer Manual" in six volumes, which was published at the Technical Publishing House.

The research done in the mineral preparation field was focused mainly on applicative issues, whose priority was imposed by the developing mining industry. Due to the high applicative research volume, needed by the production development and immediate importance these researches had, the fundamental research was reduced.

We may say that Romania formed a school of researchers, designers and preparation engineers, which solved based on their own view, the difficult and various issues presented by the national mineral preparation industry.

The highest research volume done was the one regarding the capitalization of new mineral deposits; the research revealed the technologic solutions for the mineral preparation from these deposits and represented the base of designing the preparation installations.

Therefore, they built 25 new preparation plants and developed others. They made flotation lines of 500 tonnes/day, 1000 tonnes/day and 5000 tonnes/day, and the yearly average capacity for the preparation plants was 500-600 thousand tonnes/year. Even if poorer ores were brought, the research done made possible the increased retrievals for most metals, for example led – 15-18% or zinc 30%.

The preparation research has contributed to the development of the non-metallic mineral field, supporting the foundation of preparation installation plants such as Vadul Crişului, Aghireş, Somova, Basarabi, Văleni etc.

Another research category is represented by the laboratory or enterprise research, which lead to technology improvements and capacity enhancement for the operating preparation plants such as Săsar, Baia Sprie, Cavnic, Brad, Băiţa-Crăciuneşti, Zlatna, Lupeni, Petrila and Cozla.

Beside this immediate applicative research, between 1970 and 1990 various researches aiming to introduce new methods, installations and reactive substances for mineral preparation were made.

Regarding the research for the chemical capitalization of minerals which cannot be done by classic preparation procedures, we mention the studies done by ICEMIN Bucharest and by the Mining Research Institute of Deva on the manganese ores from Vatra Dornei and Maşca Răzoare, and on potassium mineral ores from Tazlău and Gălean. Therefore, for manganese ores there was developed a procedure consisting in the leaching at 80°C with sulphuric acid of the ore, combined with pyrite and the solution separation of manganese with soda precipitation; by the calcination of the product it finally results a concentration of manganese oxides with 50-60% Mn.

In the same area of chemical capitalization we find the research which made possible a procedure for the brine evaporation through direct caloric transfer, which was patented and used currently by multiple countries for the preparation of salt within the solution.

The research regarding the synthesis and use of flotation reactive substances, done by ICEMIN Bucharest and ICEMIN Baia-Mare lead to the following results:

- The development of technologic processes for the production of collector reactive substances used currently in industry (i.e. the ethyl xanthate);
- The replacement of foams made of conifer oils with synthesis foams; therefore it was synthesized, through the poly-condensation of ethylene oxide, products with 4, 5 and 11 moles of ethylene oxide, with foaming properties;
- The improvement of the number of reactive sorts used for the mineral preparation with a series of new products – collectors, antifoam flocculants – of superior properties.

An increased number of researches regard the introduction of mathematic models for solving important issues for preparations (the installation operation control, establishing the relations between the metal extraction variations with ore content etc.).

Regarding the preparation of non-metallic ores soft concrescent, which are hard to prepare, extracted from the Oriental Carpathians, by the use of the selective-collective flotation they developed an operation technique patented worldwide, used industrially in the mining exploitation Leşul Ursului (1971) and in the mining exploitation Baia Borşa (1972), avoiding the investments needed for new metallurgy platforms, obtaining an additional recovery of copper in zinc from concentrates and saving the costs of metallurgic preparation.

After 1990, the logistics of technical and scientific progress advancement in the mining industry was ensured by the specialized activity of research-design development which took place in seven research and design profile bases, organized as commercial societies which operated in Petroşani, Craiova, Bucharest, Ploieşti, Deva, Cluj-Napoca and Baia-Mare, three units of mining informatics in Deva, Cluj and Bucharest and two state universities in Petroşani and Baia-Mare.

After 1992, when the activity of re-evaluation and reorganization of the mining units on the principles of market economy and when the support of private initiatives increased, the research-design mining institutes has suffered a large number of structural changes and reduced the number of employees and previous activities, most of them becoming private. Therefore, the mining research-design activity in Romania decreased continuously every year, due to the reorganization and to the accentuated decrease of mining production, to the lack of funds for supporting the research-design activities, to the equipment used becoming obsolete, to the researchers migration towards other activity sectors more safe and better paid etc.

The main activity of the research-design institutes, in their latest years of existence was the preparation of documents for the mining conservation and closure and for the environmental restoration from the past mining areas.

The research activity in Romanian mining continues today too, but only in the specialized departments from higher education institutions. The research themes are both fundamental and applicative. Most applicative themes used are based on the issues from the still operating mining units.

We can mention that nowadays the specialized departments from technical higher education developed cooperation relations with the similar prestigious universities from Europe or worldwide aiming to improve the research-design activity in order to solve together issues of high scientific and practical-applicative importance.

Conclusions

As a conclusion, we mention that Revista Minelor – Mining Revue has always been an active presence in Romanian mining, as it presented to the specialists and published important information on the achievements and events which took place in this economic field, among which we should mention.

1 - Within the Romanian industrialization policy after 1950, the mining industry became a main, crucial branch. They widely developed both the underground mining of minerals, but also the surface mining in large open pits, with productions of hundreds of thousands or even millions of ore tonnes years.

As a consequence, it was emphasized the knowledge of mineral sciences. Between 1950 and 1990, in all Romanian mining fields, thousands of surface drills, representing more than one million linear meters of drill holes were made. The drills, together with the surface and underground geologic research, led to the ample knowledge of the country underground and its resources.

2 - Romania is an important country as far as its mineral substances are concerned, since, among the 3,000 minerals known worldwide, one can find 500 in the Romanian underground and 35 of them were first found and described in Romania.

At present, Romania has more than 15 billion tonnes of geologic reserves of various minerals, representing a mining potential wealth of hundreds billion dollars considering the values of useful mining products after their extraction and preparation with current technologies.

Considering the approximate geologic reserves Romania has, we can mention: 3 billion tonnes lignite, 900 million tonnes black coal, 750 million tonnes gold-silver ores, 100 million poly-metallic ores, 1 billion tonnes copper ore and more than 10 billion tonnes of salt.

Also there are plenty of radioactive ore deposits, rare metals, iron-manganese, bauxite and a high variety of non-metallic substances and large quantities of useful and ornamental rocks.

3 - Romania has important industrial deposits of brown coal and lignite, in ten mining areas all over the country. The most important ones are the mining fields of Rovinari, Motru, Jilț, Albeni-Seciuri, Cerna-Cernișoara, Berbești-Alunu and Hușnicioara, here we find more than 90% of the total lignite deposits in Romania.

Among the lignite deposits, more than 80% are exploitable in open pits, while 20% are exploitable in underground mining works. In the late years, almost 90% of the total lignite production in Romania was done by the Oltenia Lignite Mining Company which coordinated the activity of 18 open pits and 12 underground mines.

The lignite extraction was done by underground mining works and open pits, while the brown coal has a smaller share in the production and was extracted by underground works. The lignite production has highly increased since 1950, reaching 50 million tonnes in 1989.

Since the beginning of the mining activity until now, Oltenia has given the production of 1.2 billion tonnes of coal, more than 1 billion tonnes of lignite being excavated in open pits with continuous and discontinuous flux works and more than 200 millions of tonnes through underground mining works.

4 - The most important achievement of the extraction industry in the 20th century was that the exploitation of three mineral substances – coal, precious metals and salt – there were developed seven sub-branches of the extractive industry: the extraction and preparation of coal, salt, ferrous ores, non-ferrous ores, precious metal ores, non-metallic ores, rare metals and radioactive minerals.

From this point of view, in Romania in the past century there were founded more than 100 mines and open pits and it was developed the production capacity of 50 mines, there were built 30 preparation plants and there were designed, built and operated 15 construction and reparation plants for mining installations.

5 - In the ninth decade of the 20th century, when the mining industry production has reached its highest peak of more than 150 millions of tonnes yearly production of various minerals, there were 278 operating mines and open pits, 70 preparation plants - 30 of them for non-metallic minerals, 34 for metallic minerals and 6 of them for coal – spread in the 41 mining areas from 28 counties of Romania. The highest productions were for lignite, black coal and iron ore.

Revista Minelor – the Mining Revue has been published monthly since 2009, under the coordination of the University of Petroșani. Today the magazine appears quarterly in small editions, due to the increased reduction of recipients, as a result of the reorganization or closure of most mines in Romania.

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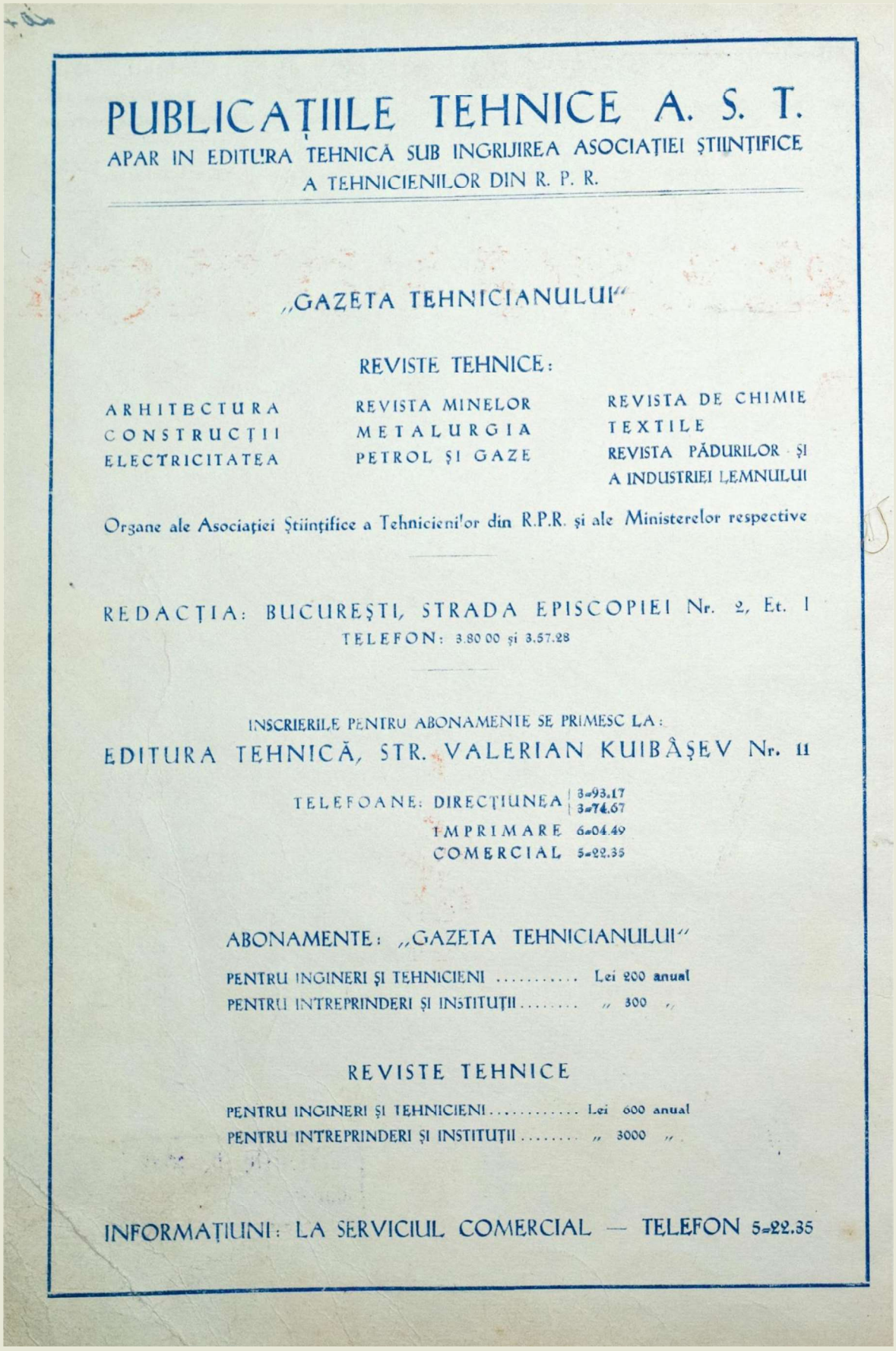

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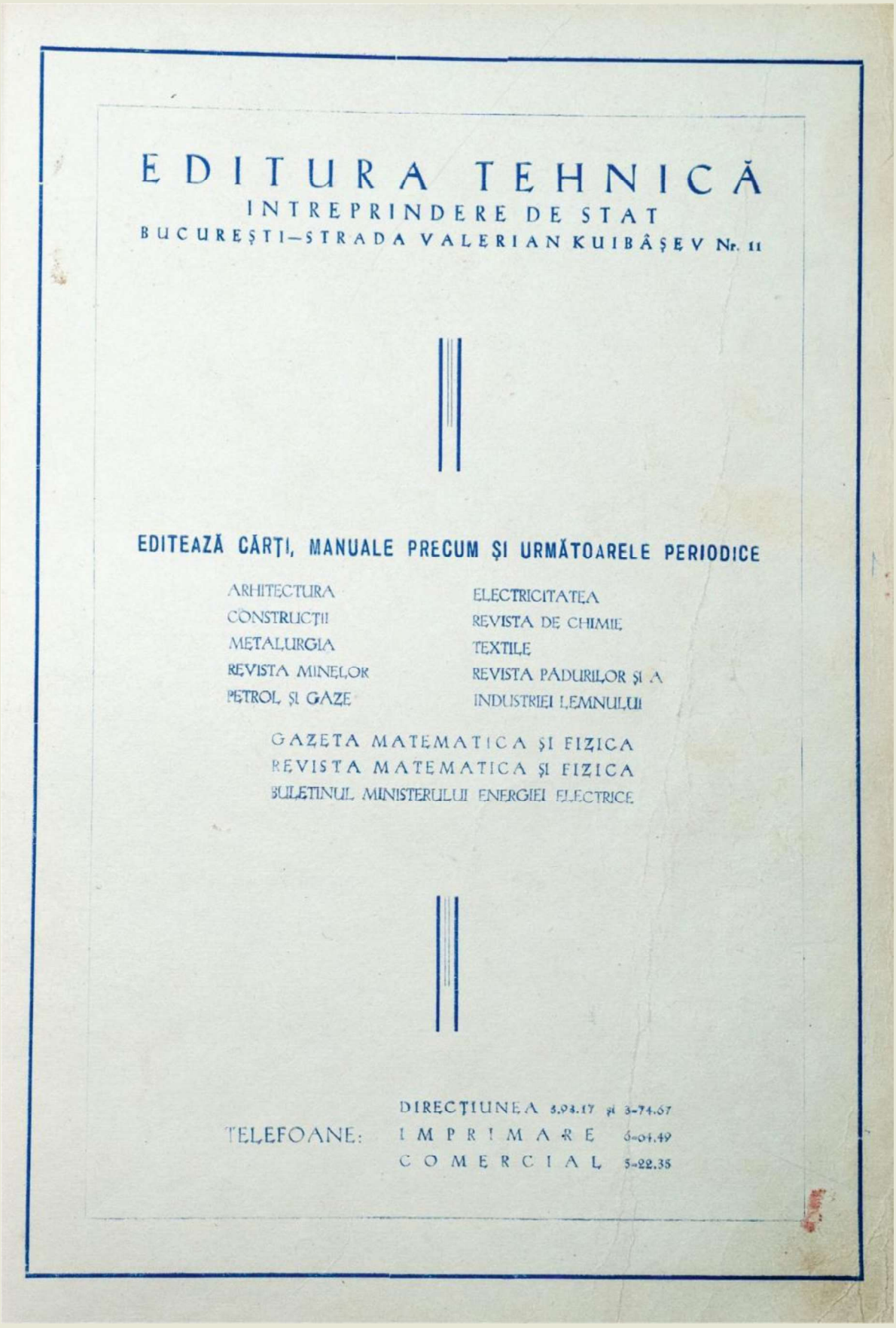

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