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CONTENTS

A DECISION-MAKING PERSPECTIVE ON THE COSTS STRUCTURE OF AN UNDERGROUND COAL MINING COMPANY

SORIN-IULIU MANGU [1]

Abstract: *Within the management system, the costs and the analytical results represent the core that coagulates, through the term of profitability, the objectives programmed decisively by the company. The planned parameters are expressed as values chosen by the management, while the resulting parameters are the expression of the way the management has run the enterprise. Each planned parameter is the expression of an objective of the company, as an economic system, through control being permanently regulated the activity of the system in order to achieve the objectives. In the field of cost calculation, controlling is not only about controlling the efficiency of the activity carried out, by comparing the planned costs with those realized. Its scope includes the rigorous substantiation of cost-based decisions. Thus, the calculation of costs has been oriented towards a wide range of managerial decisions. In making many decisions, managers make comparisons, the most commonly used element being cost. The generalization of this behavior has led to the tendency to compare companies with the same activity profile on the basis of the unit costs that they record. In mining, these comparisons are greatly accentuated, with unit costs becoming the basis and basis for decisions with multiple effects (economically, socially, politically), such as continuing activity in certain mining perimeters and closing them on others. In the branch of energy producers, unit costs have even become a fundamental element in the orientation of the strategy at national level, by focusing on the development of certain energy sources. The aspects considered in the following refer both to the attributions of the financial-accounting domain (from the perspective of forecasting and recording the costs), as well as to the cost structure and its influence on the decision-making process.*

Keywords: mining company, costs, cost structure

1. COMPARTMENTAL AND PROCEDURAL AT THE LEVEL OF THE FINANCIAL-ACCOUNTING DOMAIN OF THE MINING COMPANY

Under such branches operating mining activity across the financial-accounting concentrated at a specialized department, financial accounting, taxes, under accounting

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officer of economic, the compartment is classified, on average, with 7 positions (one head of service, one accounting post, three economist positions, one inspector post for taxes and fees, one cashier-accountant position). By the job description, for the inspector taxes and fees and the cash register, no attributions are provided regarding the costs of the branch. Thus, in a subunit which generates annual costs of about 120.000.000 - 200.000.000 RON (the equivalent of 25,000,000 - 40.000.000 EUR) are only six stations for which are set out economic activity related tasks of the actual exploitation of the oil.

For the chief accountant, who "coordinates, organizes, verifies and responds to the way the financial-accounting activity, taxes and fees within the branch are carried out, in compliance with the legislation in force" [10], through the job description, a number is provided of 21 tasks. Of these, six are related to the use of costs in the decision-making process:

- organizes the preparation of the financial planning and cost tracking works;
- organizes the periodic analysis of the use and status of the fixed assets;
- analyzes, takes and proposes measures, as the case may be, for increasing the economic efficiency;
- analyzes the production costs, takes or proposes measures to reduce them;
- organizes and ensures the timely and in accordance with the legal provisions, the verification balances, the annual and quarterly balance sheets, as well as the monthly situations regarding the main technical-financial indicators;
- participates in the organization of the information system of the branch, following the most efficient use of financial-accounting data.

Beyond the generality of the formulations, identified, by the analyzes developed in the previous paragraphs, as a characteristic of the Regulations of organization and operation, it is surprising their lack of connection with the main technical-economic documentation used at the level of mining exploitation, the General Operating Program. Only in a single statement is it referred to, through "the main technical-financial indicators". If the formulations related to the substantive organization of the accounting activities are extremely precise, the decision-making purpose of the tasks is vaguely expressed ("increasing economic efficiency" or "reducing costs"). In addition, the degree of decision-making involvement of the chief accountant, in relation to the other management positions at the branch level, is not detailed, from the perspective of substantiating the decisions regarding the use of capital and deposit production factors.

The head of service appears as involved in substantiating the decision-making process due to the following three tasks:

- draws up monthly or occasional financial-accounting statements;
- it shows the inclusion in the budget of incomes and expenses;
- in collaboration with the chief accountant, draws up the quarterly and annual preliminary statements regarding the economic-financial indicators.

The last formulation retained is likely to supplement the duties of the chief accountant, confirming his direct involvement in the elaboration of the economic part of the preliminary.

The job description "Accountant" contains a number of 17 tasks. Of these, none refer to cost forecasting and control, respectively to their use in the decision-making process. However, three are related to the accounting size of the monthly costs of the branch:

- draws up the spreadsheets and distributes the depreciation by sectors;
- draws up monthly the situation of the expenses with the depreciation, for inclusion in the production expenses;
- it leads the maturity of the unamortized values of the fixed assets canceled before the deadline and which are to be included in the production costs.

The last attribution reflects the specific character of the mining activities, but raises question marks on the relevance of using the accounting costs in substantiating the decisions.

For the first of the positions of economist there are provided exclusive attributions related to highlighting the expenses with the staff. However, the accounting side of these expenses predominates and not the one related to forecasting, substantiation or control.

For the second position of economist, although the summary of the position shows that its holder, among other things, "keeps track of the fixed assets, by categories and places of use" [10], no formulation in this regard appears in the list of tasks. Also, attributions related to the involvement in the basis of the decision-making process are not retained.

The summary of the third position of economist, by the wording "keeps track of production costs and commodity production, according to the budget of incomes and expenses" [10], confirms the involvement of its owner, together with the head of service and the chief accountant, in the elaboration the economic part of the preliminary. In this sense, three attributions are formulated:

- draws up the monthly program for production costs and freight production, according to the annual budget of incomes and expenses;
- elaborates the situation of the cost of the manufactured goods production and the cost of the coal product, on primary elements of expenses;
- draws up monthly the situation of the main economic-financial indicators.

2. POST-CALCULATION OF COSTS

At the level of mining subunit, for several decades, the application of a cost calculation method known as "phase calculation" is devoted. In fact, it is not a phase calculation, even though, in the specialized literature, the mining branch is cited as an example of a branch in which companies apply such a method of calculation.

In a first acceptance, the production of a mining subunit could be considered mass production. A closer analysis shows that, in fact, the subunit's coal production

results from summing up the orders corresponding to the coal fronts from which the coal is exploited. In the coal fronts, the technological processes are relatively different and not homogeneous (as specified in the case of companies applying the phase calculation method), due, in particular, to the different geological-mining conditions. The finished product of the mining operation subunit is not obtained by "processing in successive stages of the raw material" except in the extreme case where the production process is extended to the two fundamental stages (exploitation and preparation). However, these two stages are carried out in separate administrative units (mine, respectively preparation plant), with individualized management and clearly defined client-supplier relationships. What, inappropriately, is considered as a phase at the level of the mining subunits (preparation works, abatement works, backfilling, underground transport, underground maintenance, aeration and degassing, other underground works) does not represent successive stages of processing of the raw material (except in the process of extraction in slaughter and underground transport). Even the preparatory work, which, at first glance, seems to be a phase preceding the work in slaughterhouses, cannot be considered, in an appropriate calculation, a separate phase, because there is no direct passage from the "preparation phase". In almost no situation, the preparatory works do not refer to the same coal reserve with the abatement works, at the same economic-financial year, so they cannot be considered successive stages (in the abattoirs the "prepared" coal is exploited during calculation periods. previous, and through the preparatory work will result reserves that can be used in future calculation periods). In conclusion, it can be stated that the preparatory work can be considered expenses recorded in advance, regarding the production of future economic-financial exercises.

The analysis of the analytical accounts used in the post-calculation highlights a certain detail of them (54 analytical accounts corresponding to the synthetic account 921 "Expenses of the basic activity regarding the operating activity (direct expenses)", 24 analytical accounts corresponding to the synthetic account 922 "Expenditure of the auxiliary activities on the activity operating expenses", 21 analytical accounts corresponding to the synthetic account 923 "Joint expenses regarding the operating activity", 34 analytical accounts corresponding to the synthetic account 924 "General expenses of the operating activity"), which does not fully meet the requirements of delimitation of responsibilities and control of economic efficiency. Thus, for example, the analytical accounts used to collect the expenses for the preparatory work (92111 "Sterile preparations", 92112 "Coal preparations") do not allow their spatial and temporal identification nor the administrative responsibility at the brigade and sector level. In fact, the analytics of the calculation accounts only fulfill the common function of grouping by types of works, types of abatement technologies and types of transport. The decision value of these groups is almost zero, as long as there are no forecasts in the same structure (in order to make programmed-realized comparisons). Even time comparisons do not provide useful information in the decision-making process because the historical cost records are affected by inflation and major structural differences (which occur, practically, from one month to

another). Maintaining the current structure of the calculation accounts is perfectly possible in the future, but the utility in the decision-making process will appear only by including a calculation coding that allows the physical identification of the tasks and responsibilities in a temporal dimension (for example, in each period of calculation, the balance of the account "Preparations in sterile" will have to result as a synthesis of the balances of the accounts on individual preparatory works; similarly, the problem of the calculation and for the abatements will have to be solved). In this way, in the process of drafting the preliminary, more reliable information could be used, ensuring the premises of a detailed analysis of the efficiency of the activities carried out, with obvious effects in the decision-making plan.

3. EXPENDITURE STRUCTURE ON CALCULATION ACCOUNTS

The analysis developed in the following will attempt to highlight, in the current structure of the calculation accounts, the balances of the accounts with the highest weight, respectively of the types of costs recorded in these accounts. The data used in the analysis are related to the activity of the mining exploitation branches within the Company Complexul Energetic Hunedoara S.A. and correspond to the quarters of the year 2018.

The cost structure on synthetic calculation accounts highlights the very high share of the expenses of the basic activity regarding the operating activity and of the general expenses of the operating activity (together, on average, over 88% of the total costs). For this reason, the analysis will be oriented, first and foremost, to these calculation accounts.

Table 1. Cost structure on synthetic calculation accounts

Synthetic calculation accounts	Total costs [%]
The expenses of the basic activity regarding the operating activity	42.36 - 46.87
Expenditure on ancillary activities related to the operating activity	5.13 - 6.68
Joint expenses regarding the operating activity	5.72 - 7.04
General expenses of the operating activity	40.34 - 46.86

Table 2. Expenditure structure of the basic activity regarding the operating activity (921)

Calculation analytical accounts	Total balance account weight 921 [%]	Total costs [%]
Basic activity expenses		
Operating	16.86 - 20.42	7.52 - 9.11
Preparations	14.24 - 16.57	6.35 - 7.39
Underground transport	13.01 - 14.89	5.80 - 6.64
Expenses of maintenance activity underground		
Maintenance of mining works	22.47 - 28.32	10.02 - 12.63
Maintenance and operation of underground equipment	9.57 - 11.47	4.27 - 5.12
Other expenses with underground staff		
Vouchers	3.09 - 3.67	1.37 - 1.63
Electricity tariff difference	2.72 - 3.01	1.21 - 1.34
Protective and work equipment	0.41 - 0.46	0.18 - 0.21
Other expenses		
Compressor and fan stations	1.11 - 1.32	0.49 - 0.59
Telegrizummetric and dispatching stations	1.01 - 1.23	0.45 - 0.54
Water evacuation	0.90 - 1.01	0.40 - 0.45
Other underground costs	0.32 - 0.39	0.14 - 0.17

It is noted that there are two categories of costs that have a significant share in the structure of the basic activity's expenses regarding the operating activity:

- the costs related to the three groups of activities with the character of basic activities in the underground (abattoirs, preparations, transport), with a weight that, on average, tends to 48%, respectively to 21.45% of total costs;

- the costs related to the underground maintenance activities (maintenance of the mining works, respectively the maintenance and operation of the underground equipment), with an average weight of approximately 54%, respectively 24% of the total costs.

The weight of the other underground expenses regarding the basic activity is much lower compared to the first two categories: 24.55%, respectively 10.95% of the total costs.

The general expenses of the operating activity have, in total costs, a weight that varies between 40.34% - 46.86%. The structure of these expenditures is presented in table 3.

Table 3. Structure of the general expenses of the operating activity (924)

Calculation analytical accounts	Total balance account weight 924 [%]	Total costs [%]
Expenses with management, administrative and auxiliary staff	52.32 - 55.60	22.81 - 24.24
Share of the general expenses of SCEH SA	12.38 - 12.68	5.39 - 5.52
Expenses with medical dispensaries	5.40 - 5.89	2.35 - 2.57
Non-productive expenses	2.52 - 2.61	1.09 - 1.13
Expenditure on security and civil defense	2.43 - 2.56	1.05 - 1.11
Data processing expenses	2.78 - 2.99	1.21 - 1.30
Other general operating expenses	19.01 - 22.58	8.28 - 9.48

In the total of the general expenses of the operating activity, it is observed that the substantial share is held by those referring to the management, administrative and auxiliary personnel (who do not carry out directly productive activity). These expenses, at least in the short term, have fixed costs, and cannot be changed without taking into account radical decisions of restructuring and reorganization.

The expenses of the auxiliary activities regarding the operating activity have, in total costs, a weight that varies between 5.13% - 6.68%. The structure of these expenditures is presented in table 4.

Table 4. Expenditure structure of ancillary activities regarding the operating activity (922)

Calculation analytical accounts	Total balance account weight 922 [%]	Total costs [%]
Expenses with compressor stations	44.32 - 48.56	2.61 - 2.86
Expenses with explosives deposits	8.76 - 9.68	0.51 - 0.57
Expenditure on pump stations	7.88 - 8.68	0.46 - 0.51
CFU surface expenses	7.54 - 8.21	0.44 - 0.48
Costs for the carpentry workshop	6.78 - 7.42	0.40 - 0.43
Expenses with the electric workshop	5.31 - 5.62	0.31 - 0.33
Other expenses with ancillary activities	14.56 - 16.34	0.85 - 0.96

The first two items of expenditure (with a total average weight of 55.71%) are compartmentalized individually and as a liability, however, having the character of "untrue" common costs. In fact, these expenses are directly related to the consumers of compressed air and the explosive, in the work fronts.

The joint expenses regarding the operating activity have, in total costs, a weight that varies between 5.72% - 7.04%. The structure of these expenditures is presented in table 5.

The first two items of expenditure (with a total average weight of almost 68%) concern an area of activity that is not under the control of the mining level management. These costs represent a direct consequence of the way in which the top management of the Company decides in the issues regarding the relations with third parties for the provision of works and services.

Table 5. Structure of the common expenses regarding the operating activity (923)

Calculation analytical accounts	Total balance account weight 923 [%]	Total costs [%]
Maintenance and repair of equipment (incurred by third parties)	33.23 - 37.42	2.12 - 2.38
Expenditure on transport of materials by third parties	30.45 - 34.78	1.94 - 2.21
Expenditure with personnel from the surface sector	13.67 - 15.69	0.86 - 1.00
Expenses with the depreciation of the fixed assets of the surface sector	13.25 - 14.96	0.84 - 0.95
Other common expenses related to the operating activity	3.12 - 3.87	0.19 - 0.24

4. CONCLUSIONS

The current system of finding, evaluating and recording the expenses at the level of branch mining does not allow the structuring of costs according to the behavior criterion in relation to the activity level (the most useful criterion, from the perspective of relevance, for the decision-making process). The situations presented above, referring to the four synthetic calculation accounts, point out, however, that from a decision-making perspective, the cost analysis in the cost structure should be oriented, in particular, towards the expenses of the basic activity regarding the operating activity and the general expenses of the operating activity. Such a conclusion is justified by at least the following arguments:

- the expenses of the auxiliary activities regarding the operating activity have an average weight of about 5.90% in total costs (which does not exceed 7.20% for any mining exploitation branch);
- the common expenses regarding the operating activity have an average weight of approximately 6.40% in total costs (which does not exceed 7.80% for any mining exploitation branch);
- about 50% of the total expenses of the auxiliary activities regarding the operating activity (on average, 2.75% of the total costs) represent expenses with the compressor stations (which involve particular analyzes, in relation to the operating program);

- even if, in the total of the expenses of the auxiliary activities regarding the operating activity, the second weight (on average, 15%) is held by an item of individualized expenses (other expenses with the auxiliary activities), its weight in total costs is insignificant (below 1 %);

- approximately 68% of the total common expenses regarding the operating activity (on average, 4.35% of the total costs) is determined by the costs with the works and services performed by third parties (which require particular analyzes, depending on the real needs of the mining exploitation branches);

- approximately 14% of the total common expenses regarding the operating activity (on average, less than 1% of the total costs) represent expenses regarding the depreciation of the fixed assets of the surface sector;

- approximately 14.50% of the total common expenses regarding the operating activity (on average, no more than 1% of the total costs) are personnel expenses (which can be analyzed by including in the structure of the expenses with the personnel at the mining exploitation branch level).

Consequently, from the perspective of the structure on calculation accounts, the expenses of the basic activity regarding the operating activity, respectively the general expenses of the operating activity, remain important for the decision-making process. In detail, in the structure of these synthetic calculation accounts there are at least three components (the expenses of the basic activity in the underground: abattoirs, preparations, underground transportation; the expenses of the underground maintenance activity: the maintenance of the mining works, the maintenance and operation of the underground equipment; the expenses with the expenses; management, administrative and auxiliary personnel), with a share of over 60% in total costs, which should be included in a rigorous system of cost forecasting and control, able to provide information relevant to the decision-making process.

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CONSIDERATIONS ON THE FOUNDATION OF DECISIONS USING THE PRODUCTION FACTORS CAPITAL AND DEPOSIT IN THE UNDERGROUND COAL MINING OPERATIONS

SORIN-IULIU MANGU [1]

Abstract: *Participants in the economic and social circuit, the Romanian mining companies are separated as entities of management of the consumed resources and the obtained results, and the object and the purpose of the activities carried out by them are of a lucrative type. Currently, most of national mining activities are organized almost exclusively as mining companies owned by the state. In the collective perception at national level, the coal mining is associated to the Jiu Valley. With the largest coal field in Romania, the area became "economically interesting" only about 150 years ago. Underground coal mining has been, throughout this period, the main (and sometimes the only) factor of economic development of the entire region. After 1990, a long period of transition led to the transformation of a mineral wealth (special form of capital) into a generative element not of welfare, but rather of economic problems with serious social and even institutional consequences. We did not intend for this paper to analyze or comment in detail the evolution of mining companies from the Jiu Valley in terms of profitability, restructuring or adaptation to the rigors of a certain economic system. However, taking advantage of the availability of certain information, we tried to focus on the decision-making process related to the use of capital and deposit production factors.*

Keywords: mining company, decision-making process, access plan for coal reserves, general operating program, costs, calculation items, primary items of expenditure

1. THE ACCESS PLAN FOR COAL RESERVE

The plan for access to the coal reserves is a comprehensive document, which includes both the presentation of the current methodology for substantiating the decisions to continue or cease activity in the mining perimeters related to the subunits of the Complexul Energetic Hunedoara S.A., and their effects (in terms of staggering the development and extraction activities in the mining perimeters where the activity will continue).

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Even if the name of the document analyzed could induce the idea of structural homogeneity (from the perspective of reflecting, with priority, the way of capitalization of the coal reserves, so of the use of the deposit production factor, correlated with the factor of capital production), its chapters are much different under the aspect of the content and the way of writing.

he first chapter is devoted to the presentation of the general aspects of the Company's activity. Thus, information regarding the history of coal exploitation in the Jiu Valley basin, the constitution, the legal status, the form of organization and the shareholding of the Company, the object of activity of the Company and the products offered on the market, the mining perimeters within the coal basin, the technical endowment of the subunits are revealed. The Company, the methods of exploitation used, the impact of the coal exploitation on the environment, the current situation of the works of closure and conservation of some mines, the economic effects of the activity of the Company, the influences of the activity of the Company at national level and on the programs negotiated by Romania with international bodies (World Bank), organizational structure and staffing, the effects of the restructuring programs started since 1997, the main indicators reflecting the current economic and financial situation of the subunits of the Company .

Chapter two is extremely brief. Basically, it consists of a list, developed on a single page, which presents the selection criteria that mining companies must meet in order to be included in the Coal Reserves Access Plan. The list includes two groups of criteria: technical and economic in nature. At the level of this chapter is used the concept of viability (viable mining, respectively viability analysis). The concept is not clearly defined, but the criteria presented induce the idea that viability is related to the ability of the mining operations to meet certain conditions that describe a certain evolution over time.

Chapter three is an applicative one, but relatively limited. Based on the criteria set forth in the previous chapter, the overall degree of viability of the subunits of the Company is determined. Those subunits that meet the viability conditions or reach them at the end of the period considered are included in the Coal Reserves Access Plan. Those who do not meet the conditions fall into the category of those for which the Program for cessation of activity and closure will be drawn up.

Chapter four, the most extensive, has a predominantly economic content. The chapter begins with a working document, in which the evolution of inflation is estimated, until 2020, on the prices of the main materials used (rubber band, straps for SG profiles, extraction cables, flat cables, detonating electrical staples, fuels, protective equipment, explosives, support beams, individual lamps with accumulator, mining chain, mine wood and wood semi-finished products, conveyor spare parts, spare parts for extraction installations, wire mesh, SG support profile, rollers and roller garlands for conveyor belts, bearings, tools and cutting tools, anchor string, SVJ type individual support posts, steel pipes, coals and other lubricants). Next, a document with basic format, is used to present information regarding the activity of the current year (values realized / forecast), respectively forecasts up to the level of the year 2020, for each

subunit of the Company, and globally. The document, entitled “Information on carboniferous production”, is written in three variants: A1 - current year (achievements), C1 - current year (achievements, respectively previous forecasts), B1 - (forecasts, period up to year 2020). From the point of view of the structure, it includes two main groups of information: general information (net production, productivity, caloric characteristics production, underground jobs, total jobs provided), respectively production costs (personnel costs, material costs, depreciation) direct, credit repayment expenses, transportation expenses to delivery points, general business expenses, other expenses, supply costs, debts accrued in previous years and restructuring costs, compensatory payments, debt and penalties increases, asset costs ceded, expenses for research and development works, expenses for environmental protection, total deductions, costs related to current production). In variant B1, the document also includes three main groups of information: deliveries and inputs, losses eligible to receive state aid, proposed state aid to be received.

Chapter five presents how to use the deposit production factor. For each subunit declared viable, based on the analyzes and information from the previous chapters, corresponding to the time period extended from the current year to the year 2020, the volume and the sequence of the opening and preparation works, the evolution of the volume of open reserves, the works of presentation are presented. exploitation, evolution of production capacity and annual production. Basically, at the level of this chapter, the main information related to the future use of the deposit production factor is synthesized, corresponding to the previous decisions based on the viability analysis. However, the economic content of the chapter is extremely limited, predominating the technical component (materialized in the form of staggered graphs of the execution of the opening and preparation works). Thus, the future maintenance or development of production capacities are not substantiated by economic evaluation studies, in which the main efficiency indicator, the return on invested capital, will be highlighted.

Chapter six focuses on how to use the capital production factor. Related to the developments in the use of the deposit production factor, the investment program of the analyzed period is presented. The observation related to the lack of substantiation of decisions through economic studies remains valid at the level of this chapter (in the Investment Program there is no reference to such studies or methodologies for estimating efficiency indicators). The character of the chapter is, mainly, a forecast one, due to the annual budgets of incomes and expenses presented. They are built on the principle of balance, correlated with the programs of use of capital and deposit factors, but with the inclusion of administrative provisions, with significant effects on the way of estimating the future evolution of expenses and incomes.

The last three chapters are less relevant from the perspective of our analysis, being mainly devoted to the environmental problems associated with the evolution of the Company's activities.

The plan for access to the coal reserves is the first document that contains elements to substantiate the decisions to use the factors of capital production and deposit. The foundation takes the form of the feasibility analysis, whose economic

dimension is relatively limited (both from the point of view of the relevance of the economic indicators used, as well as from the way of determining the economic efficiency indicators).

2. GENERAL OPERATING PROGRAM

The general operating program represents a comprehensive and complex forecasting documentation, which substantiates and, at the same time, reflects the decisions regarding the use of capital and deposit production factors. The general exploitation program (called "preliminary" in the current language of the technical and economic cadres at the level of the mining companies) is drawn up annually, ensuring the classification of each subunit in the tasks broken down from the annual budget of the Company Complexul Energetic Hunedoara S.A. to the annual budget of incomes and expenses, which is broken down by quarters and months, according to the established production and the estimated level of expenses, realized in the previous year [4].

Although we do not have historical information to attest the appearance, evolution and use of the general exploitation program, we can say, without any mistake, that this documentation relates to the idea of “organized” mining activities. At the time of our analysis, the preliminary appears in the position of main documentation of synthesis of the forecasting efforts by which are reflected the fundamental aspects related to the transposition of the decisions of use of the factors of capital production and deposit in annual programs of action. The four-part structure (written part, main technical-economic indicators, charts, topographic plans) reflects the technical-economic character of this documentation.

By its specificity, the mining activity involves the execution of works that advance to the reserve bodies (geological research works, opening works), works that outline the coal faces and provide them with utilities (preparatory works, assembly and arrangement works) and exploitation works proper to coal (logging works). Also, the existing mining works must be maintained, in order to remain in working order, and in the underground, the quality parameters of the atmosphere necessary for the safe operation of the activity must be ensured. All categories of works mentioned are described in the written part of the preliminary. In addition, the written part is supplemented with information regarding the state of the coal reserves, the operating licenses, the annual investment program, the effects of the exploitation and the transport and preparation of the coal extracted on the environment.

The preliminary diagrams summarize the volumes of works and the volumes of production (preliminary and respectively realized), with the nomination of the works. By this way of tracking the forecasts and comparing them with the achievements, at the end of the period, this part of the preliminary provides the informational basis necessary for analyzing the way in which the decisions on the use of capital and deposit factors have been materialized.

The information summarized in the diagrams is presented graphically in the topographic plans. These include both the works scheduled for the next year (quarter) and the areas from which the coal production will be extracted, as well as the stage of their execution (progress), as the preliminary is realized.

As a direct consequence of the concerns of controlling the economic efficiency of the activity carried out, a fourth part of the preliminary, entitled "Main technical-economic indicators" appeared. Through the set of documents grouped under this name, each mining subunit within the Company Complexul Energetic Hunedoara S.A. tries to achieve the classification in the tasks broken down from its annual budget (approved by Government Decision).

Starting from the annual task indicators, communicated by the Economic Direction within the Company, each mining subunit elaborates its own set of documents “Main technical-economic indicators”, with a predictive character, through which it ensures the detailing and correlation of the general indicators. The documents drawn up are the following:

- The situation of open and prepared reserves (1);
- Geological research works (2);
- Opening-investment works (3);
- Preparation-discovery works (4);
- Production capacities, front line (5);
- Production by sectors (6);
- Layer production (7);
- Production by exploitation methods (8);
- Extracted reserve, operating losses, dilutions, degrees of recovery (9);
- Ash weighted by stratum and blocks (10);
- Stamens (11);
- Maintenance work (12);
- Works for environmental protection and restoration (13);
- Conservation-closure works (14);
- Specific consumption of materials, energy and fuels (15);
- Production, personnel, productivity (16);
- Production costs (17);
- Budget of incomes and expenses (18);
- Program for using technological equipment (19);
- The centralizing of personnel by structure (staff and positions) (20).

Of the documents listed, 15 are directly related to the use of capital and deposit production factors (the first 14 and document 19), two reflect the use of the labor force production factor (16 and 20), and three represent synthesis documents, with a predominantly economic content (15, 17 and 18).

Documents 2, 3, 4, 12 and 14 (which present projections related to the evolution of the structure of the mining works network) reflect the operationalization of previous decisions regarding, essentially, the volume or level of production. The execution of the categories and volumes of works provided for in these documents will

have effects on the quantities of reserve that can be exploited (document 1), concretizing the way of producing the mining production (document 5). Documents 6, 7, 8, 9 and 10 represent centralizing situations corresponding to a first level of synthesis. Based on them and the provisions of documents 15, 16 and 19, the two main synthesis documents (17 and 18) are elaborated, with economic character.

3. COST STRUCTURE AND DECISION-MAKING PROCESS

From the perspective of controlling the economic efficiency of the activity carried out, for the needs of the decision-making process, currently, at the level of a mining exploitation branch, two centralizing situations are drawn up, reflecting the cost structure: The situation of the cost of the product "coal" on computing articles, respectively the situation the realization of the cost of the product "coal" on primary elements of expenses. Both documents are drawn up monthly and include the preliminary values, respectively realized for the current month, as well as the cumulative situation since the beginning of the financial year.

Compared to those found during the analysis of the cost structure on calculation accounts, the usefulness of the "Situation of the cost structure on calculation items" in the decision-making process is debatable. Of the costs pursued, two have zero value, six have weights less than 1%, and one has a weight of about 3%. As a result, a number of 9 individual costs (out of a total of 16) have a weight that does not exceed 10% in total costs. Instead, there is a cost item, other special expenses, with an average weight of 10%, the structure of which is not detailed. Also, there is no detail of the structure of the joint departmental expenses, respectively of the general administrative expenses. Hence, the obvious conclusion that the cost analytical situation, as a result of applying a management accounting system, is not used properly in the decision-making process.

The current cost calculation system used allows the grouping of expenses in relation to their genesis, reflecting the consumption of production factors. However, the cost situation of each mining company, entitled "Situation of the cost of coal product on primary elements of expenses", differs in structure from the situations presented in the works of calculation established in the specialized literature (which highlight the following categories of expenses: personnel costs, expenditures on stored consumptions, expenses on works and services provided by third parties, costs on taxes, taxes and assimilated payments, expenses on depreciation and provisions for depreciation of assets and those for risks and expenses, expenses on calculations) [4]. Regarding the usefulness of the decision-making process, the same objections as in the case of the "Cost statement on calculating items" can be raised regarding the "Cost statement on primary items of expenses". The analysis of the cost structure reflected by these documents also highlights one aspect: the lack of correlation, in terms of form and content, between the two situations currently drawn up and the main economic documents of the General Operating Program: specific consumption of materials,

energy and fuels (document 15), production costs (document 17), revenue and expenditure budget (document 18).

4. CONCLUSIONS

The analysis of the decision-making process regarding the use of capital production and deposit factors was customized at the level of the underground coal mining companies in the Jiu Valley. Following the analysis, in synthetic form, the following main conclusions can be retained:

- even if they are "stubborn" from the perspective of the duties and tasks retained in the account of the top level management posts and the compartments, the Regulations for the organization and functioning of the Company and the mining operation contain a small number of attributions regarding the decision-making process associated with the use of production factors capital and deposit, but suggests the idea of connecting it with the main forecast and control document used in the mining activities, the General Operating Program;
- the analysis of the main documents used in the decision-making process (Mining industry strategy, Restructuring program, Coal reserves access plan, General exploitation program) showed that the Coal reserves access plan is the only document that contains elements to base the decisions the use of capital and deposit production factors (in the form of viability analysis, whose economic dimension is relatively limited);
- from the analysis of the General Operating Program, a wide and complex documentation of forecasting and control, resulted the importance of costs in the decision-making process associated with the use of capital and deposit production factors;
- for the needs of the decision-making process, on a regular (monthly) basis, at the level of a mining operation, two centralizing situations are drawn up, reflecting the cost structure (Situation of the cost of the “coal” product on calculation items, respectively Situation of the cost of the “coal product” on primary expenditure items). From the point of view of the cost components pursued, the two situations are not correlated with the General Operating Program;
- the procedures for estimating the production and, implicitly, of the expected costs, both in the Plan of access to the coal reserves and in the General exploitation program, do not have a reliable foundation. Hence, reservations regarding the use of these forecasts in the decision-making process.

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3D NUMERICAL MODELLING OF THE BEHAVIOR OF A SHAFT UNDER THE INFLUENCE OF THE UNDERGROUND MINING

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DACIAN-PAUL MARIAN [2]
ILIE ONICA [3]

Abstract: *In this paper it is analyzed the way how the stability of a vertical shaft PB5,5 (concrete shaft, B350, with an internal diameter of 5,5m) is affected at the approach of the longwall face. After such an analysis, the boundary of the safety pillar can be determined and, if this limit is exceeded, can be determined the most affected areas of the shaft's structure. Therefore, the purpose of this research was to analyze how a shaft behaves, under the influence of the underground mining, in the geological and mining conditions specific to the Jiu Valley coal basin. In order to achieve this study, was used the 3D finite element numerical modelling, using the CESAR-LCPC software.*

Keywords: numerical modelling, finite element, concrete shaft, tensile strain, compressive strain, horizontal displacement, coal seam, underground mining.

1. INTRODUCTION

The vertical shafts are main long-life mining works, executed with the purpose of opening underground deposits of useful mineral substances and ensuring the ventilation of the mines, the transport of the production, materials and personnel, the evacuation of the water, the transport of the backfill etc. In most cases, the extraction and ventilation shafts are used throughout the whole life of a mine, for which, in their setup as well as in the choice of the excavation and support solutions many geological, hydrogeological and topographic factors must be taken into account (Popa et.al. 1993).

Depending on their position in relation to the deposit, the shafts can be located as follow (Onica, 2016):

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- They can cross the deposit – in the case of thin coal seams or small ore deposits (in this case the volume of the reserves lost in the pillar shafts will not be very large);
- They can be placed in the rocks in the floor of the deposit – in the case of thick coal seams or thick ore deposits (thus avoiding the design of safety pillars containing a large volume of reserves);
- They can be placed in the rocks from the roof of the deposit – recommended only in the cases where are no conditions to place them in the deposits or in the floor rocks.

2. DESCRIPTION OF THE 3D MODELS

In order to carry out this analysis, it was assumed the extraction of a horizontal coal seam, with a thickness of 5m, the coal seam being located at an average mining depth of H = 200m.

It was considered that the coal seam is extracted by top coal caving longwall mining method (the length of the longwall face being l_{ab} = 150m), on 9 phases of extraction with a panel extention of X_{ca} = 0m, 25m, 50m, 75m, 100m, 125m, 150m, 175m and 200m (namely, the stress states in the concrete lining were modeled, starting from a stress state of the shaft unaffected by the underground mining, X_{ca} = 0m, then successively increasing the size of the mined space by 25m each, to a shaft approach of 5m). It was considered that the shaft reaches the surface, and with respect to depth, it exceeds the depth of extraction (or the coal seam) by 10m (Figure 1).

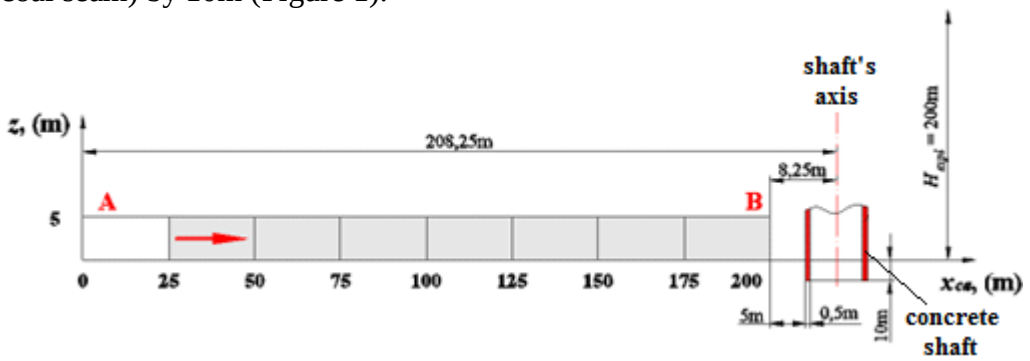


Fig. 1. The extraction phases captured in the 3D numerical models

3. MODELS ACHIEVEMENT

In order to reduce the calculation time and the dimensions of the finite element model, a symmetrical model was adopted according to the z0x plane, resulting in numerical models with the dimension of: X = 710m, Y = 400m, Z = 225m.

To create the 3D models, first was created a 2D model, in which the discretization of each region of the model was done by finite elements of surface, triangular or square (were possible), with linear interpolation (Figure 2).

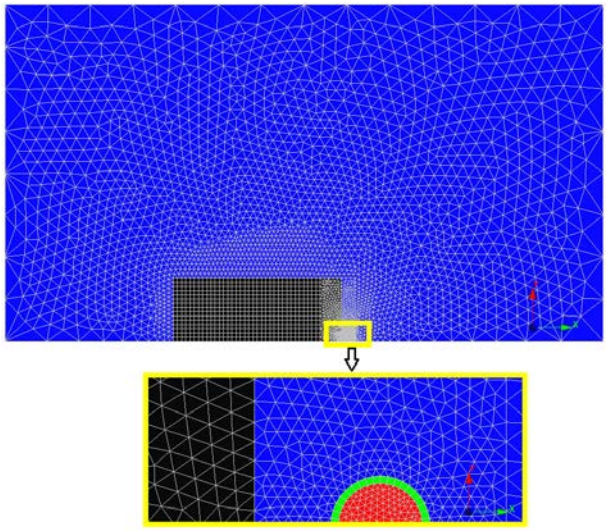


Fig. 2. The discretization of the finite element model – the achievement of the 2D model

After making this model, using the extrude command, the 3D model was generated, thus executing each area of the massif, resulting in volumetric triangular prisms whose height is arranged along the Z axis (figure 3).

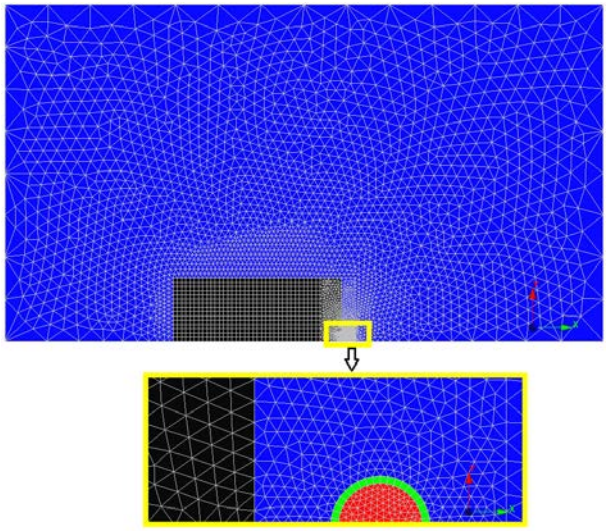


Fig. 3. Realization of the 3D model

For simplicity, three areas with different geomechanical characteristics (that of the rocks in the massif; the space resulted from the coal extraction and the hole in the center of the shaft; of the concrete shaft) the characteristics of the rocks, considered homogeneous and isotropic, were taken into account in the hypothesis of the elastic behavior. The characteristics adopted in the finite element model for the rock massif (Hirian, 1981; Todorescu, 1984) have been with a structural weakening coefficient and are: average apparent density $\rho_r = 2\,663 \text{kg/m}^2$, elasticity modulus $E_r = 1{,}511 \cdot 10^6 \text{kN/m}^2$ and Poisson's ratio $\nu_r = 0{,}19$. The concrete strengths are given in table 1 (Georgescu, 1978).

Table 1. Concrete strengths

Type of stress	**Symbol**	**Concrete**							
		B100	**B150**	**B200**	**B250**	**B300**	**B400**	**B500**	**B600**
		$\cdot 10^2$ kN/m^2							
Centric compression (prismatic strengt)	R_{pr}	45	65	80	100	130	170	200	230
	0,85 R_{pr}	40	55	70	85	110	145	170	195
	0,75 R_{pr}	35	50	60	75	100	130	150	170
Bending compression	R_i	55	80	100	120	160	210	250	280
	0,85 R_i	45	70	85	100	135	180	210	240
	0,75 R_i	40	60	75	90	120	160	190	210
Tensile	R_t	4	5	6,5	7,5	9,5	11	12,5	13,5

Note: The reduced values in the table correspond as follow:

- 0,75 R_{pr}; 0,75 R_i for pylon, diaphragms and walls with a smaller cross-sectional dimension (below 30cm), vertically molded;
- 0,85 R_{pr}; 0,85 R_i for elements molded in horizontal position with the side of the section below 30cm as well as for elements molded in vertical position having the minimum section size of 30cm or more.

Regarding the boundary conditions of the finite element model, the upper part of the model was considered free, and the lower part and the lateral parts were blocked (for the lower part the vertical displacements $w = 0$ and the horizontal displacements $u \neq 0, v \neq 0$, and for the sides $w \neq 0$, $u \neq 0$ and $v = 0$ for the sides of the model parallel to the *X*- axis and $w \neq 0$, $u = 0$ and $v \neq 0$ for the sides of the model parallel to *Y*-axis.

Because the values of the real stresses in the massif are not known, being not measured in situ, the initial loading conditions of the 3D model were considered geostatic, related to the average mining depth of $H = 200$m.

The calculus were performed taking into account a number of 60 iterations per increment with an accuracy of the results of 1%, for solving using the initial stresses method.

4. ANALYSIS OF THE RESULTS

Following the calculations made on the numerical models mentioned above, the results were obtained regarding the displacements and the stresses appeared in the resistance structure of the lining, namely:

- horizontal and vertical displacements (*u, v, w*);
- state of stress in the reference system „0,x,y,z", $\sigma_x, \sigma_y, \sigma_z, \sigma_{xy}, \sigma_{yz}, \sigma_{zx}$, in KN/m^2;
- the maximum, average and minimum stresses $\sigma_1, \sigma_2, \sigma_3$, in KN/m^2;
- the stresses after Von Misses criterion, *v*33, in KN/m^2;
- tensile, compression and shear stresses in KN/m^2;

The obtained results are presented in table 2.

Table 2. The results obtained by 3D numerical modelling

Type		Unit	Panel length – X_{ca} (m)								
			0	**25**	**50**	**75**	**100**	**125**	**150**	**175**	**200**
u	min	mm	-0,855	-1,35	-4,7	-9,6	-15,8	-22,8	-29,8	-36,1	-40,7
	max		0,859	1,7	3,8	6,99	11,4	17,1	24	30,5	50,6
v	min	mm	-0,851	-0,823	-0,751	-0,634	-0,651	-0,793	-1,09	-1,56	-1,89
	max		0,001	0,001	0,004	0,005	0,005	0,001	0,25	0,7	3,17
w	min	mm	0,17	-0,97	-4,31	-10,2	-19,4	-32,4	-50	-73,9	-116
	max		3,37	3,28	3,01	2,5	1,6	-0,1	-3,6	-12,3	-26
xx	min	kN/m^2	-12300	-12500	-13000	-13700	-14700	-16200	-18000	-21300	-50000
	max		0	300	800	1400	1900	2100	1800	1000	24300
σ_{yy}	min	kN/m^2	-12300	-12200	-12000	-11700	-11300	-11800	-12900	-14700	-32300
	max		0	100	300	400	500	345	266	300	8000
σ_{zz}	min	kN/m^2	-14800	-14900	-15400	-16300	-17800	-20500	-25500	-37100	-102000
	max		0	0	0	0	0	162	662	1700	3621
σ_{xy}	min	kN/m^2	-4700	-4720	-4780	-4880	-5030	-5260	-5710	-6790	-15600
	max		4700	4720	4770	4850	4970	5180	5610	6230	13100
σ_{yz}	min	kN/m^2	-2800	-2790	-2780	-2750	-2690	-2580	-2370	-3340	-11700
	max		690	690	690	690	690	1090	2020	3550	15500
σ_{zx}	min	kN/m^2	-2850	-2850	-2850	-2840	-2820	-2760	-2550	-1510	-7000
	max		2840	2830	2800	2750	2660	2510	3670	7020	23000
σ_1	min	kN/m^2	-3020	-3030	-3090	-3170	-3350	-3480	-3670	-4060	-6900
	max		20	260	820	1520	2230	2810	3260	3720	27400
σ_2	min	kN/m^2	-11800	-11900	-12400	-13200	-14400	-16100	-17900	-20400	-41300
	max		0	0	100	135	163	147	321	600	850
σ_3	min	kN/m^2	-15800	-15900	-16300	-17000	-18300	-20900	-25800	-37800	-104000
	max		0	0	0	-90	-218	-384	-525	-517	-632
Shear	min	kN/m^2	0	30	100	190	290	410	666	1300	2245
	max		6520	6570	6730	7030	7610	8770	11200	17400	51600
Von Mises	min	kN/m^2	0	100	100	200	210	215	345	900	3200
	max		9920	10100	10500	11200	12500	14700	19700	31400	87800
Tensile	min	kN/m^2	0	0	0	0	0	0	0	0	0
	max		18,3	265	825	1520	2230	2810	3260	3722	27400
Compression	min	kN/m^2	-15800	-15900	-16300	-17000	-18300	-20900	-25800	-37800	-104000
	max		0	0	0	-100	-200	-400	-525	-518	-632

Analyzing the horizontal and vertical displacements that appeared in the shaft's structure, it can be observed that they have negligible values in the initial phase (before the extraction), but as the longwall face approaches the shaft, they increase significantly, especially the horizontal displacement following the direction of advancement of the longwall face (which reaches values between -40.7mm and +50.6mm at a shaft approach of 5m) and the vertical displacement (or subsidence, which reaches values between -26mm and -116mm). The graphical representation of the displacements is shown in figure 4 and the scalar representation in figures 5-7.

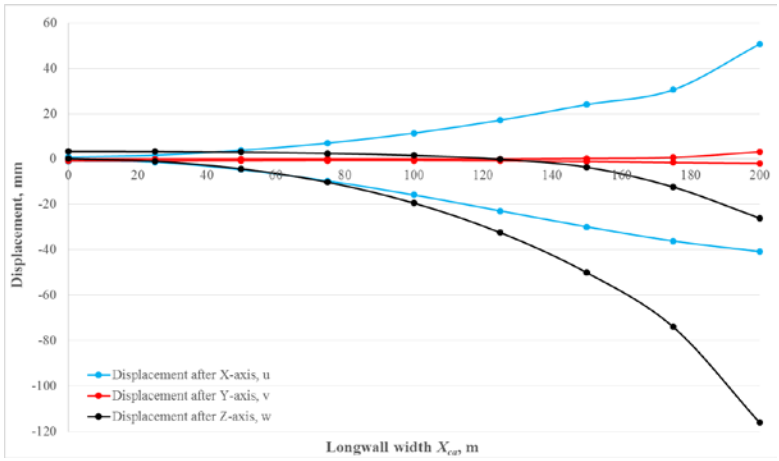
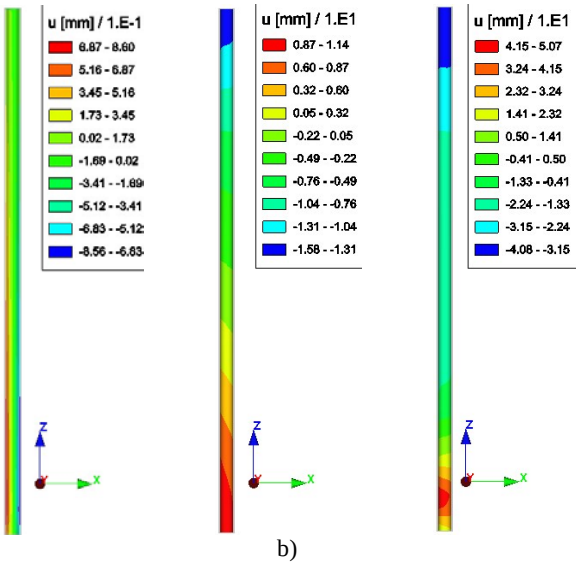
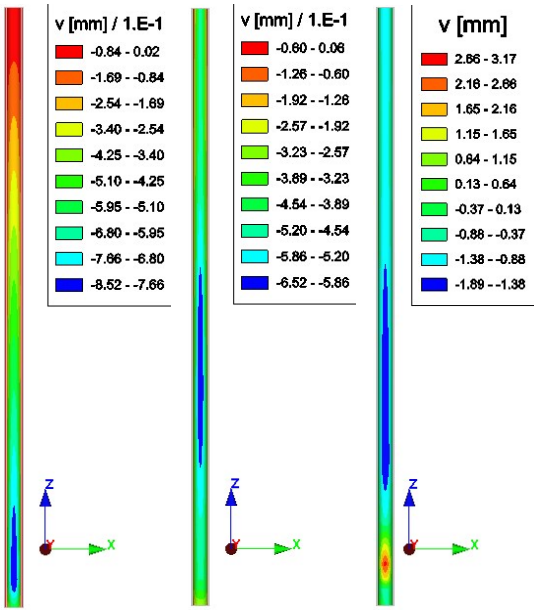


Fig. 4. The graphs of the displacements appeared in the structure of the shaft with the advancement of the longwall face



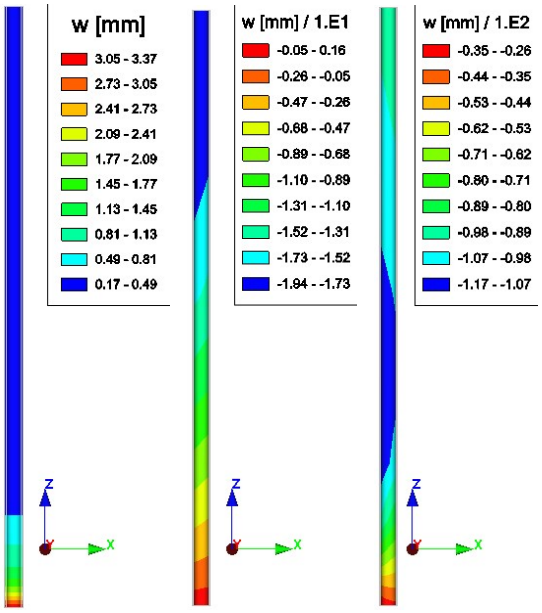
a) b) c)

Fig. 5. The scalar representation of the horizontal displacements from the shaft's structure along the X-axis: a) X_{ca} = 0m; b) X_{ca} = 100m; c) X_{ca} = 200m



a) b) c)

Fig. 6. The scalar representation of the horizontal displacements from the shaft's structure along the Y-axis: a) X_{ca} = 0m; b) X_{ca} = 100m; c) X_{ca} = 200m



a) b) c)

Fig. 7. The scalar representation of the horizontal displacements from the shaft's structure along the Z-axis: a) X_{ca} = 0m; b) X_{ca} = 100m; c) X_{ca} = 200m

Regarding the equivalent stresses according to the Von Mises criterion, they start from a maximum value of 9920kN/m^2, before coal extraction, have a slow growth up to a length of the extracted space of X_{ca} = 125m-150m (namely, up to a distance from the shaft of approx. 80-50m) and then they grow sharply reaching the maximum value of 87800kN/m^2 at a distance of 5m from the shaft. The evolution of these stresses as the longwall face advances is graphically represented in figure 8 and the scalar representation is shown in figure 9.

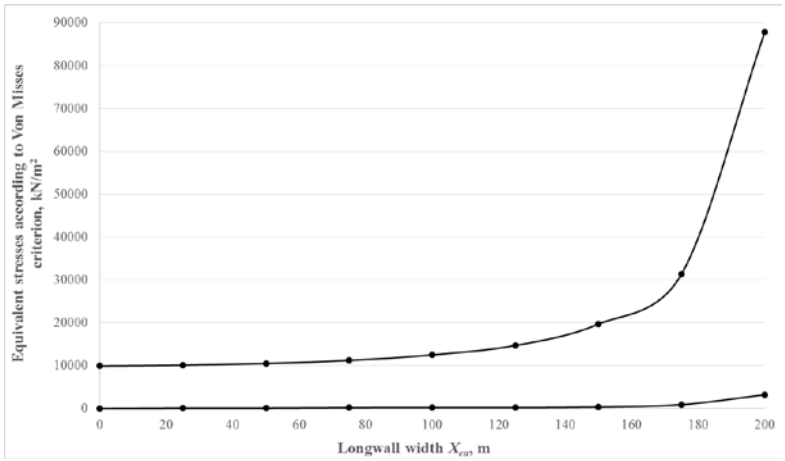
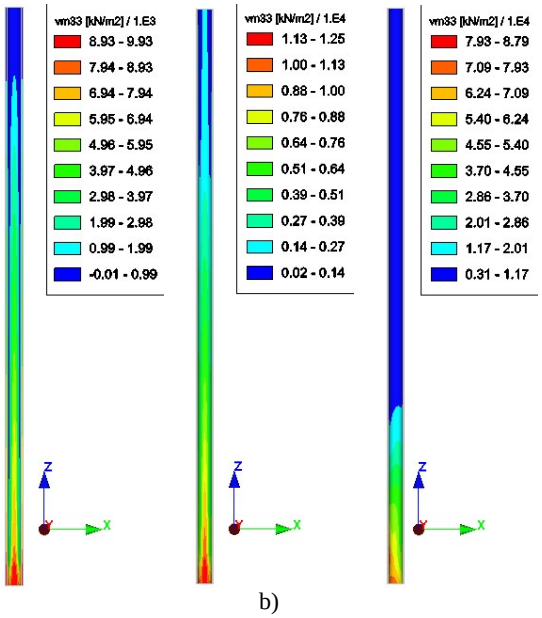


Fig. 8. The graphs of the equivalent stresses according to Von Misses criterion v33, appeared in the structure of the shaft with the advancement of the longwall face



a) b) c)

Fig. 9. The scalar representation of the equivalent stresses according to Von Misses criterion v33 from the shaft's structure for: a) X_{ca} = 0m; b) X_{ca} = 100m; c) X_{ca} = 200m

Analyzing the tensile stresses appeared in the shaft's structure it is observed that before the coal extraction they reach the maximum value of 18,3kN/m^2 at the top of the shaft, it presents a significant increase with the beginning of the extraction (reaching the value of 825kN/m^2 for X_{ca} = 50m), they grow almost linearly up to X_{ca} = 175m (where they reach the maximum value of 3722kN/m^2) and then grow suddenly, reaching at a distance from the shaft of 5m the value of 27400kN/m^2. The evolution of tensile stresses as the longwall face advance is graphically represented in figure 10 and their scalar representation is shown in figure 11.

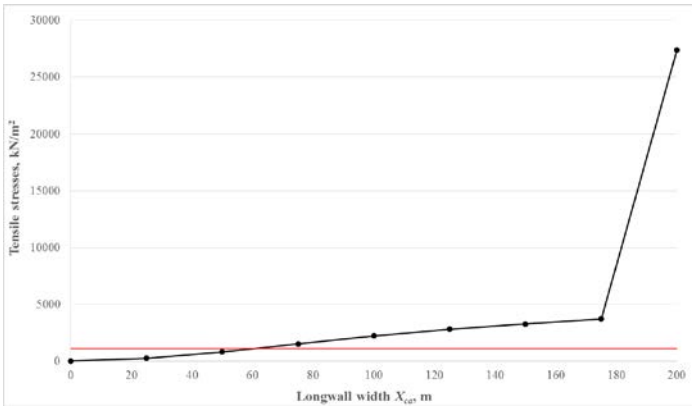
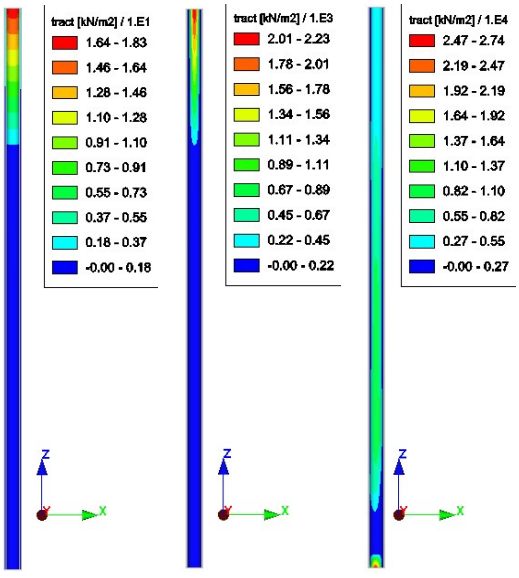


Fig. 10. The graphs of the tensile stresses,
appeared in the structure of the shaft with the advancement of the longwall face



a) b) c)

Fig. 11. The scalar representation of the tensile stresses from the shaft's structure for:
a) X_{ca} = 0m; b) X_{ca} = 100m; c) X_{ca} = 200m

Considering that the concrete used for the shaft is B400, it is observed that the tensile strength (which for B400 is 1100kN/m^2) is exceeded at a length of the extracted space that exceeds 50m (that is, at a distance from the shaft below 155m, for the conditions taken into account).

Regarding the compressive stresses, they exceed the compressive strength (which for B400 is 17000kN/m^2) at a length of extracted space of 75m (that is, at a distance from the shaft below 130m, for the given conditions – figure 12).

In these conditions, from the numerical modelling, it turns out that the limit of the safety pillar for the considered conditions would be 155m. Above this limit the resistance structure of the shaft is affected.

The compressive stresses reach a maximum value of 15800kN/m^2 at the bottom of the shaft before starting the coal extraction, they slowly increase to a distance of approx. 70m from the shaft's axis (reaching the value of 25800kN/m^2 for X_{ca} = 150m), after which they suddenly grow to the value of 104000kN/m^2 at a distance from the shaft edge of 5m. The graphical representation of the compressive stresses, as the advance of the longwall face, is shown in figure 12 and their scalar representation is shown in figure 13.

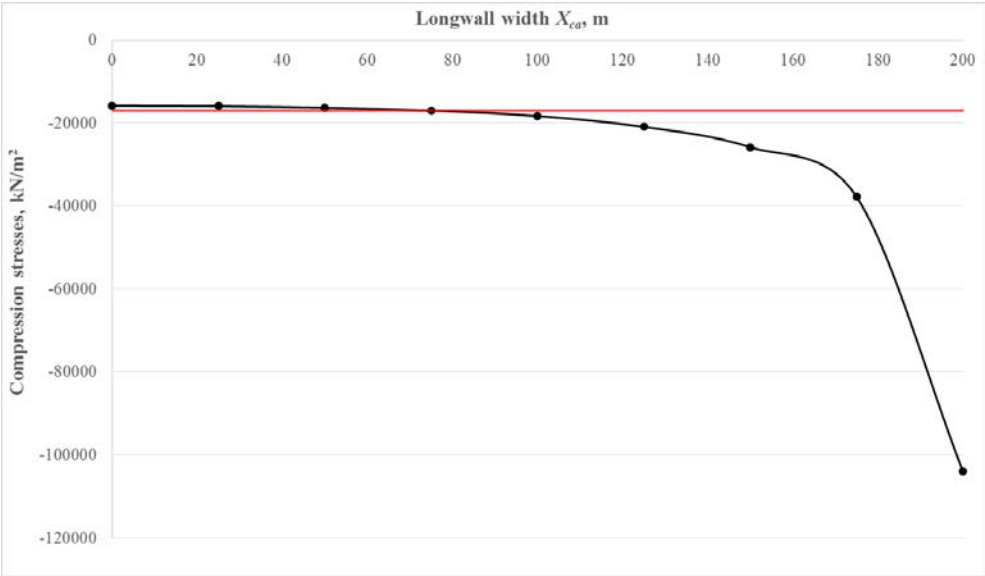
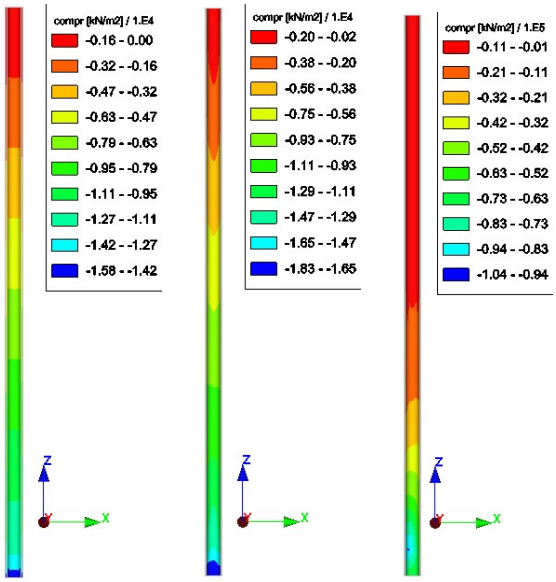


Fig. 12. The graphs of the compressive stresses, appeared in the structure of the shaft with the advancement of the longwall face



a) b) c)

Fig. 13. The scalar representation of the compression stresses from the shaft's structure for:
a) X_{ca} = 0m; b) X_{ca} = 100m; c) X_{ca} = 200m

The shear stresses developed in the shaft's structure have a maximum value of 6520kN/m^2 in the initial phase analyzed by numerical modelling, have a slow increase until an extension of the extracted space of X_{ca} = 150m, where they reach the maximum value of 11200kN/m^2, after which they grow rapidly to the maximum value of 51600kN/m^2 at a distance from the shaft's edge of 5m. The graph of the shear stresses, which appeared in the shaft's structure with the advance of the longwall face, is shown in figure 14 and their scalar representation is shown in figure 15.

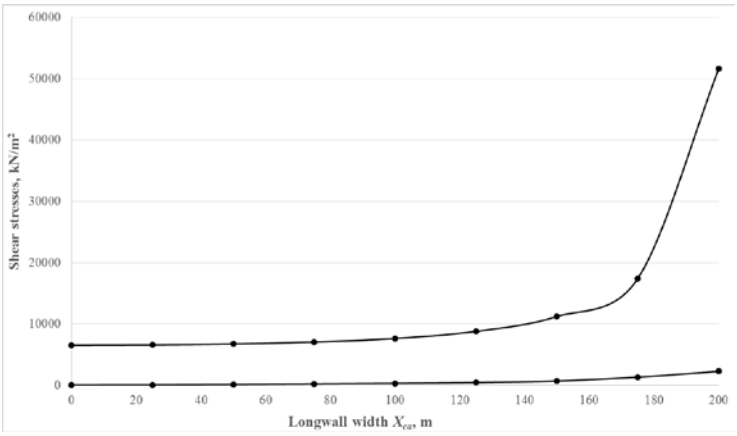
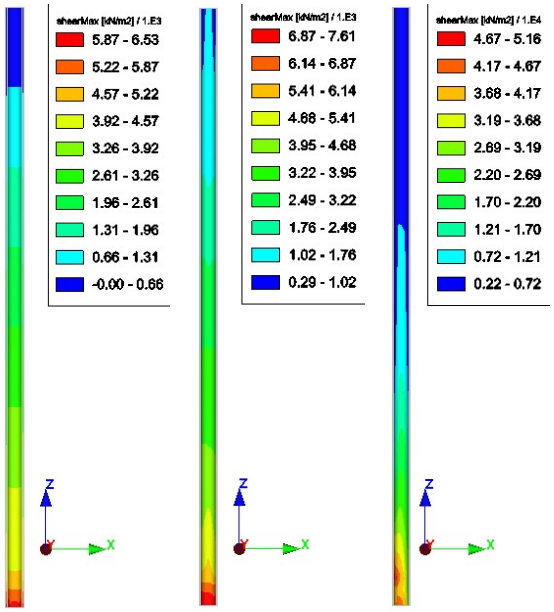


Fig. 12. The graphs of the shear stresses,
appeared in the structure of the shaft lining with the advancement of the longwall face



a) b) c)

Fig. 13. The scalar representation of the compressive stresses from the shaft's structure for: a) X_{ca} = 0m; b) X_{ca} = 100m; c) X_{ca} = 200m

5. CONCLUSIONS

In this paper, a study was carried out regarding the analysis of the behavior of a shaft under the influence of the underground mining. In this case, a theoretical situation was analyzed in which we followed the behavior of a shaft with the advancement of the longwall face. In this case, it was assumed that the mining depth is 200m, being analyzed different positions of the longwall face.

As a result of this analysis it is found that the underground mining exerts a certain influence on the shaft from the first phase of the extraction. As the longwall face goes forward the stresses and deformations increase slowly, almost linearly, up to a shaft approach of approx. 40-50m after which they have a sudden increase.

The application of the numerical modelling in the analysis of the state of stress appeared in the structure of resistance of the constructions, located on the surface or underground, as a result of the underground mining gives a clearer picture of the deformation of the objectives located in the mining areas. Also, carrying out such analyzes can lead not only to a better understanding of the subsidence phenomenon but also to the development of technical solutions to protect the objectives from the surface or underground, or to diminish the negative effects generated by the underground mining.

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TECHNIQUES OF CLEANING WASTEWATERS WITH HEAVY METALS CONTENT

CAMELIA BĂDULESCU [1]

Abstract: *The paper presents a synthesis of the processes and technologies for the purification of mine waters loaded with heavy metals. By combining the different wastewater cleaning processes, wastewater treatment technologies results. The technological flow must ensure the reduction of pollutant concentrations below the limit allowed by the legislation in force. Mainly, the purification of mine waters requires pH adjustments, ensuring the conditions for producing redox reactions and stabilizing the residues resulting from the treatment. The main processes for wastewater treatment, classified according to the mechanism that leads to the reduction of the pollutant are: physical, chemical and biological processes. Their combination allows for advanced purification.*

Keywords: industrial wastewater, heavy metals, chemical processes, physical processes, biological processes, active and passive treatment technologies

1. INTRODUCTION

The waste water from the mining industry does not comply with the quality conditions required by the legislation in force regarding: pH, total suspensions, sulphate content, heavy metals, fixed residue, etc.

As pollutants, heavy metals are among the most toxic because of their long persistence in solutions and the difficulty of being transformed into insoluble compounds in surface waters. The danger of heavy metal contamination is increased in the presence of complexing agents, which strongly bind these metals into soluble compounds, which cannot be removed during water treatment.

Pollution of industrial wastewater is the most massive and harmful category of pollution. The causes of the pollution of industrial wastewater emissions originate from the „gaps" in the conception about the production process, the summary examination of the secondary phenomena that influence the results of the basic process, the elimination of waste and by-products without special concerns regarding the consequences that may have on the environment.

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In heavy metal pollution of industrial waste water, the largest contributions have the activity of the mining industry, the mineral processing industry, the metallurgical industry, the chemical industry.

2. PROCEDURES OF INDUSTRIAL WASTEWATER CLEANING

The choice of one of the processes is based on: the quantity of effluent, the content in pollutants, the quality conditions imposed by the legislation in force, the financial means of the economic agent.

2.1. Physical procedures for wastewater treatment

In these processes, pollutants do not undergo transformations into other substances. These processes include: sedimentation, flotation, centrifugation, filtration, membrane separation, phase transfer.

Sedimentation involves the gravitational separation of coarse particles, not dissolved in water, under the influence of the gravitational field, this process can be intensified by coagulation and flocculation (R. Sarbu, 2008).

Flotation is the separation process based on the differences between the surface properties of the solid particles. At the base of this process is the adhesion of solid particles to the gas bubbles with the formation of bubble-particle aggregates to be transported to the surface of the water, forming a foam that is removed by different processes (S. Krausz, P. Ilie, 2001).

Centrifugationis the process of separating the suspensions from the water in centrifugal field. Sedimentation rates are high, which results in a greater mass separation of mineral suspensions in the unit of time.

Filtration - is the process of passing water through a porous environment, on which the retention, through predominantly physical phenomena, of some of the constituents of waste water takes place.

Membrane separation. The membrane is defined as a phase that acts as a barrier for the molecular or ionic species in the water, through which the membrane can only pass water molecules. Of the processes that use membrane separation, the largest use is: direct and reverse osmosis, ultrafiltration and electrodialysis.

2.2. Chemical procedures for wastewater treatment

Through chemical purification processes, the pollutants are transformed into other substances more easily separated such as: insoluble precipitates, gases, which have a lower harmful activity or are more likely to be removed. The chemical procedures applied for wastewater treatment are: neutralization, oxidation and reduction, precipitation, coagulation and flocculation, ion exchange on resins.

Neutralization is a process by which the pH of a water is regulated by the addition of acids or bases. This process also has the effect of reducing the corrosive properties of the water.

Oxidation and reduction - the purpose of this process is to convert undesirable chemical compounds into less harmful ones.

Precipitation realizes the transformation of pollutants from wastewater into insoluble products that can be subsequently separated from water. Cyanides, salts of alkali metals, sulphides, ortho-phosphates, proteins, aromatic amines can be removed by precipitation.

Coagulation and flocculation. The term coagulation is used to describe the destabilization process produced by the compression of the two electrical coatings that surround the colloidal particles, which makes it possible to aggregate them and thereby decrease the specific surface of the system. The term flocculation refers to destabilization by adsorption of large polymer molecules that form bridges between particles.

Treatment by ion exchange is based on the property of some materials, which come into contact with mineralized water (containing ionized salts), replacing the ions in the water with the ions coming from the material itself.

2.3. Processes for biological treatment of waste water

By biological purification is meant the complex of operations and technological phases through which the organic matter existing in the waste water is transformed, with the help of cultures of microorganisms, into products of harmless degradation and a new cell mass (biomass), harmless.

Biological treatment of wastewater containing metal ions can be done by two methods:

- Reduction of metals and their precipitation in the form of sulfides by means of sulfate-reducing bacteria; Sulphate-reducing bacteria have the ability to reduce the sulphate ion by several steps, until the formation of hydrogen sulphide, which reacts with metal ions from wastewater and transforms them into precipitating sulfides and thus can be separated and removed by decantation and filtration.

- Extraction of metals from water through their sorption on biological materials, process known as biosorption of metals. (C.Badulescu, 2010). The process uses living or dead biomass to hold impurities, especially rare metals and radioactive metals, from waste water.

3. TECHNOLOGIES FOR CLEANING WASTEWATERS WITH HEAVY METAL CONTENT

The technologies applied are both the traditional ones, but many innovative variants have appeared, with lower costs and without affecting the purification performances.

3.1. Traditional technologies treatment of wastewaters with heavy metal content

Treatment in ponds - involves the addition and mixing of lime in the water stream, with the possibility of depositing precipitates in a pond. This process is characterized by simplicity, low costs. They can be used for high water flow rates and high metal concentrations but require large land areas. Also, this procedure does not allow the existence of a system control.

Treatment in basins - is similar to the one in ponds, but requires additional water pumping. This process allows a better mixing of water with lime, but there is the possibility of reforming suspensions under strong wind conditions, the possibility of uncontrolled penetration of contaminated water into the basin or through seepage.

Conventional treatment of wastewater containing heavy metals - implies a neutralization of water in a tank, by controlled addition of lime until the desired pH value is reached, after which a flocculant is added.The water thus treated feeds a clarifier for solid-liquid separation. The thickener is collected at the base of the scrubber and can be pumped into a storage area or subjected to filtration, in press filters, to increase density before transport. The overflow can be directly discharged or filtered through a sand filter to reduce the content of solid suspensions.

HDS (high density sludge) treatment of wastewater can be considered a standard in wastewater treatment. Figure 1 shows the HDS wastewater treatment system (B.Aube et al., 2004).The particularity of this treatment technology is the mixing of the thickened recirculated with lime before the neutralization. This fact favors the precipitation on the surfaces of the existing particles of the calcium hydroxide with favorable consequences on their size and density.

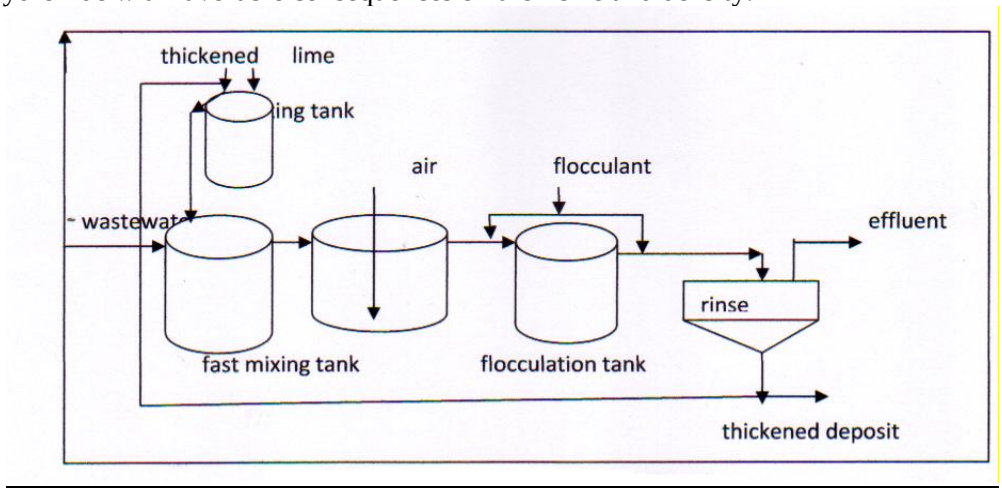

Fig. 1. HDS system of wastewaters treatment

The treatment of wastewater containing heavy metals by neutralization in successive stages - aims to improve the crystalline state of the precipitates and to

educate the volume to be thickened. This system has been patented in the US and Canada (Demopoulos, G.P. et al. 1997, Zink, J.M. and al. 2001).

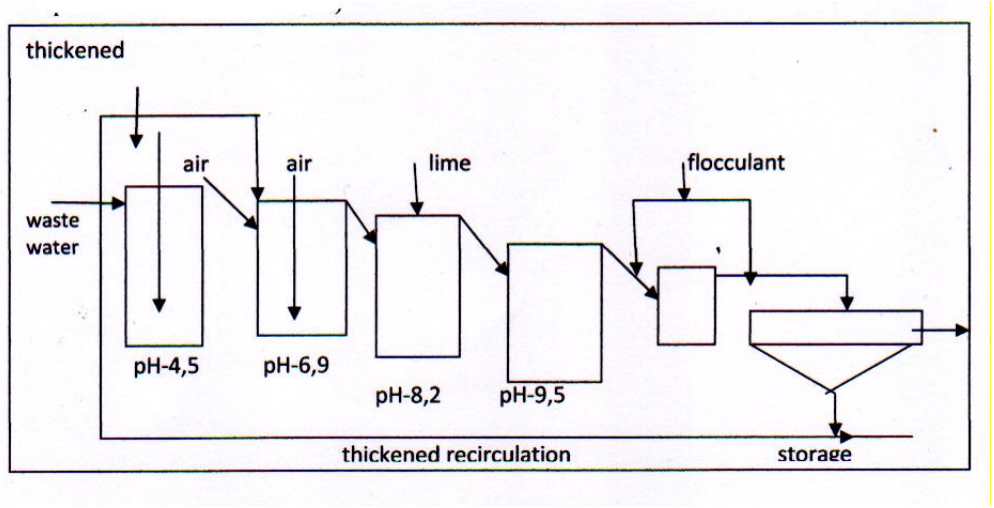

Fig. 2. Technology ensures water neutralization, in a series of steps

This technology ensures water neutralization, in a series of steps controlling the level of supersaturation during metal precipitation (fig. 2). The system uses the thickening recirculation in the first two reactors for the partial neutralization of waste water. In reactors 3 and 4, lime is dosed to increase the pH to the specified value. The flocculant has the role of increasing the size of colloidal particles.

3.2. Innovative technologies treatment for wastewater with heavy metals content

These technologies use physical, chemical and biological processes that most often occur naturally in the environment and modify the characteristics of the wastewaters. These can be considered attractive for treatment of wastewater containing heavy metals, due to the low costs of construction, operation and maintenance, as well as the ability to operate in remote locations with limited operating requirements.

Passive mine water treatment technologies were introduced around 1990, in the United Kingdom, during which time many mines were closed. Currently, there are 6 types of passive systems for treating mine waters:

- Aerobic wetlands also called reed beds (Laine, 1997);
- Anaerobic wetlands with compost, with a large flow surface;
- Systems with mixture of lime stone and compost;
- Reactive barriers below the surface for the treatment of acid mine waters; (Sobolevski, A., 1997);

- Lime closed systems for alkaline water treatment in order to remove zinc; (Younger, P.L, 2000);
- Filters for aerobic treatment of ferrous mine waters (Wildeman, T.R. et.al, 1997)

The natural and built wetlands have become more and more imposing due to the low costs of construction and operation, simple monitoring over time, advanced technology, landscape remediation of the area and attractiveness for wildlife.They work on the basis of biological, physical and chemical mechanisms, supported by elements of the system such as: aquatic plants, microorganisms or soil types or substances used for plant development. The processes that occur in wetlands are oxidation, reduction, precipitation, adsorption, complexation, sedimentation, filtration, active absorption of plants, bacterial mechanisms. Upon passage of mine water through wetland, the heavy metals are progressively eliminated and neutralized. The heavy metals are eliminated by precipitation, chelization and ion exchange, while the neutralization of water is done by reducing sulfate bacteria or by increasing alkalinity through chemical or microbial reactions, including limestone dissolution.

Passive mine water treatment systems typically use natural or constructed wetland combinations supplemented with chemical amendments (limestone) and organic substrate to increase alkalinity and reduce acidity. They can be aerobic and / or anaerobic. The following are considered:

- Increased pH;
- Removal of metals:

1) sulfide. CuS, ZnS, PbS, NiS, FeS2, CdS;

2) Hydroxides: Fe (OH) 3, Al (OH) 3, Mn (OH) 2;

3) Carbonates: FeCO3, MnCO3, ZnCO3.

Drainage through lime-stone is a channel filled with lime-stone, crushed, sealed in plastic or geochemical fibers, covered by the soil, through which the stream of uncharged, gravitationally contaminated water flows.When the water passes through the channel, the mine water dissolves the limestone, releasing the calcium in the form of bicarbonate, which increases the pH. It is important that oxygen does not participate in this process because it leads to the formation of hydroxide precipitates which inactivates the surface of limestone particles or prevents the passage of water through the channel.

Passive bioreactors - have been used for over 20 years in the treatment of mine waters. (Dvorak, D.H. et al, 1992, Reisman, D.J., 2003, C.Badulescu, 2010).These passive bioreactors are based on reducing sulfate bacteria, which are found in natural environments where anoxic conditions prevail.

The sulfate-reducing bacteria (BSR) group is the only physiological group of bacteria that has a positive effect on the environment. The metabolism of these bacteria can be used in different technologies for the bioremediation of water, soil, oil and oil production and many other industries.

At the same time, the activity of BSR may be of practical interest in a number of biotechnological applications such as:

- precipitation of metal ions from wastewater;
- removal of sulphates from polluting environments;
- the production of H2S from industrial waste (such as phosphogips whose composition is over 90% sulphates), which is then bacterially oxidized to elemental sulfur;
- bioremediation processes of metal ion-contaminated media based on the production of H2S-type biogenic sulphides.

The ability of microorganisms to concentrate metal ions in their dilute solutions, by direct adsorption or absorption, has already been demonstrated. The fixation phenomena occur either active, via living cells, or passively, independent of metabolic activity, respectively via dead cells.

The mechanisms, in the case of active processes based on oxidation-reduction reactions, complexation with the surfaces of microbial cells, ion exchange, precipitation and intracellular embedding, can be grouped into three categories, namely:

1. metals reduction - results in a decrease in valence. This important mechanism is best known for reducing mercury, whose incorporation into cells as mercury ion (Hg2 +) is carried out by an active, genetically controlled transport system. After incorporation, the mercury ion is reduced to Hg0, which diffuses into the cell, being lost in the aqueous phase, by volatilization. Ferric iron ions also undergo a reduction process, while they act as electron acceptors for some bacteria such as: Pseudomonas sp., Micrococcus sp., Rhodopseudomonas or Thiobacillus. The reduction of manganese oxides under the action of bacteria is another way realized under the action of some intermediate metabolism products. The phenomenon is encountered by the bacterium Thiobacillus thiooxidans, which, growing on elemental sulfur, produces H2S and sulfite, which react with MnO2.

2. metals precipitation - this process taking place under the action of bacteria such as: Desulfovigrio Sp., Desulfotomaculum Sp., Desulfomonas Pigra etc, which produce H2S, which reacts with free or adsorbed metal cations, which it precipitates in the form of metal sulfides. The process takes place in nature, causing immobilization of metals in aquatic sediments. This process can be used to concentrate the heavy metals, followed by their secondary recovery, but also to treat the effluents of the mines or the industrial ones in order to recover the heavy metals. This process achieves a double effect: removal of sulphate ion and heavy metal ions from industrial effluents;

3. metals recovery - an example may be the recovery of silver from aquatic suspensions, a mechanism that has not been sufficiently elucidated. It has been shown in the case of the microbial association of: Pseudomonas maltophila, Staphylococcus auoeus and Corynobacterium Sp., which efficiently accumulate 921 mg Ag/g biomass /hour, ensuring the complete removal of silver. The phenomenon is also realized with other bacterial associations of the type Thiobacillus that can accumulate silver sulphide up to 250mg Ag / g dry biomass / hour (R.O.Koch, 1991, V. Groudeva, 2001).

Biosorption systems - are used in the case of lower concentrations of metals, as a secondary stage of water treatment, when integrated with other treatment systems. As

biosorbents it can be used: a mixture of Cladophora algae to remove manganese and increase the pH when passing through wetland.

Non-living biomass can also be used to reduce metal concentrations in mine waters, during the process an ion exchange occurs between biomass and the components of mine water. One biomass used was BIO-FIX- which is manufactured from dry biomass mixed in a high density polysulfonate dissolved in an organic solvent. The raw materials for this biosorbent can be: seaweed, blue-green algae, yeast, common lentil and finely ground peat. With this biomass they were able to remove: As, Cd, Cu, Ag, Pb, Zn, Mn. (Bennett P.G.et.al, 1991).

4. CONCLUSIONS

Industrial waste water is characterized by a high concentration in heavy metals whose elimination or reduction implies the application of physical, chemical or biological processes.

By combining the different processes, wastewater treatment technologies are born whose flow must ensure the reduction of pollutant concentrations below the limits imposed by the legislation in the field.

From the technologies presented in the paper, it is observed that the active ones provide a higher efficiency for the treatment process but with higher costs compared to the passive technologies which, if used correctly, can ensure an acceptable degree of depollution, but large areas of land are needed as well. subsequent activities to treat the areas where the accumulation of heavy metals is carried out.

In order to choose the most suitable method of treatment of wastewater containing heavy metals, a comparative study is required, depending on the composition of the waste water to be treated, the level of neutralization that can be achieved and the concrete conditions existing in the respective locations.

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RESEARCH ON IMPROVING DRINKING WATER QUALITY USING OZONE TREATMENT

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Abstract: *The natural / raw water captured from any source can't qualitatively meet all the requirements demanded by the areas in which it is used, so that a permanent need for a permanent monitoring of its parameters is required; when some of these parameters do not correspond to the area in which the water is used, it intervenes through the treatment plants, so that at the end of the process the water meets the qualitative standards in force. In this context, the present paper aims to analyze, on a comparative basis, several methods of drinking water treatment.*

Keywords: water treatment, chlorination, ozonation, UV

1. INTRODUCTION

Water, an indispensable element of human life and activity, is an important indicator of the appreciation the degree of civilization and the development opportunities that a community offers to its inhabitants.

In our days, waters as well as the entire environment are subject to an aggressive impact generated by the development of society on the basis of polluting technologies, as well as all human activity. That's why the protection of water quality has become today one of the major concerns, which influences the life on our planet.

Research has highlighted the fact that, along with the quantitative problems of localities water supply, there are also high quality (physical, chemical and bacteriological) deficiencies of drinking water with repercussions on the health of the population.

Some of the risk factors for drinking water contamination are:

- low efficiency of treatment processes;
- lack of sanitary protection of water sources;
- the lack of adequate qualification of the operational staff at the level of the water treatment plants.

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As I mentioned, one of the risk factors for drinking water contamination is the low efficiency of treatment processes. This low efficiency is primarily due to the treatment of chlorine water that has its disadvantages and limits.

The scientific research reveals the adverse effects of chlorine in water to the detriment of public health and the environment. Chlorination also causes corrosion of metallic pipes and affects the smell and taste of water.

Another major problem would be that some pathogen agents have already acquired resistance to chlorination, which, of course, leads to poor quality drinking water.

2. ADVANCED METHODS OF DRINKING WATER TREATMENT

2.1. Generalities

Conventional water treatment methods are: sedimentation, coagulation, filtration (physical or biological), then disinfection. Optional methods could be: mineralization, demineralization, deferrization, etc. (Corui A., Sarbu R.,2006)

Disinfection is usually done by chlorination (chlorine, chlorine dioxide, chloramine), but also by ozonation, iodination or bromination, or by silver, potassium permanganate, etc.(Robescu D. N., Lanyi S., Robescu D,2000)

The main drinking water disinfection technologies currently used are:

- Disinfection with chlorine and its derivatives;
- Disinfection with chlorine dioxide;
- Disinfection with bromine compounds;
- Electrophysical disinfection procedures (Cu2 + and Ag + ions)
- Disinfection procedures by membrane separation;
- Disinfection procedures with PHMB (Polihexamethylenebiguanida);
- Ultraviolet (UV) disinfection procedures;
- Ozone disinfection procedures

In order to analyze these technologies, you need to look at some basic parameters such as:

- the effectiveness of disinfection technology;
- ease of operation;
- environmental impact;
- the impact on the human user;
- the degree of occurrence of the by-products of the reaction;
- operating costs.

In most cases, we need to clean non-discriminatory classes of water components, not just the toxic ones, which also leads to removal of desired substances, especially at high costs, high reagent consumption, frequent filter change, etc.

In Romania, have been defined in HG 100/2002 for the approval of the NTPA 013 Water Quality Standard, the following three standard water treatment technologies for the conversion of surface water categories A1, A2 and A3 into potable water:

- Category A1: Simple physical treatment and disinfection (eg rapid filtration and disinfection);
- Category A2: Normal physical, chemical and disinfection treatment [egpreclorination, coagulation, flocculation, decantation, filtration, disinfection (final chlorination)];
- Category A3: Physical chemical treatment, advanced chemical treatment, perchloration and disinfection [eg intermediate chlorination, coagulation, flocculation, decantation, adsorption filtration (on activated carbon), disinfection (ozonisation, final chlorination)].

Among the chemical substances used in the treatment of water are: lime, aluminum sulphate, chlorine, calcium hydroxide, caustic soda, carbon dioxide, sodium carbonate, ferrous sulphate and ferric sulphate, active coal dust or granules, sodium, polyelectrolytes, ammonia, phosphates, copper sulphate, potassium permanganate, hypochlorites, sodium chloride, clays, etc.

Although the substances are very diverse, the active element and mechanism is common to several categories.

2.2. Treatment of water with ozone

Water treatment plants have quite different structures depending on size, complexity, used technologies, etc.

There are also mini-treatment stations or even individual devices. Still, the treatment steps are often the same and the same principles.

Ozonation consists of treating water with ozone, a powerful oxidant that also has advantages and disadvantages. Ozone is found in small quantities in the atmosphere and near electrical equipment - TV tubes, xeroxes and sometimes air conditioners. Wherever there is a spark in the presence of oxygen, ozone is formed. (Ulinici, S., Suciu, L., Vâju, D., 2008).

Ozone has strong oxidizing properties. It is an unstable gas, depending on temperature and air pressure. It decomposes rapidly in oxygen at temperatures above 35o C.

It has a specific smell and can be felt by most people at an extremely low concentration (0.02 ppm / volume). It is relatively water soluble, the solubility depends on the temperature of the water, and the types of liquefaction processes. The ozone molecule is a strong oxidizing agent capable of forming strong chemical reactions that contribute to additional oxidation reactions.

The development of ozonation as a current practice in drinking water treatment has mainly developed due to harmful products resulting from chlorination (formation of halogenated compounds). (Ulinici, S., Vlad, G., Vâju, D., Suciu, L., 2011).

The time required to obtain a 99% disinfection against bacillus coli is seven times shorter if ozone is used than if chlorine is used. The rate of destruction of bacillus megatherium cereus spores is 300 times higher. Although the sporicidal effect of ozone is considerable, large amounts of ozone are needed to destroy them.

According to other researchers, a 60,000 coli/l emulsion is destroyed by chlorine at a concentration of 0.1 mg / l for 4 hours, while the ozone has the same effect in 5 minutes at 22 ° C and 0.5 seconds at 37□C.

Plankton, algae, protozoa, larvae and worms are also destroyed in short time; for example, protozoa, including histological entamoeba, are destroyed in 3 minutes at a dose of 15 mg / l ozone.

Under the same conditions, ozone reacts faster on bacillus coli, spores and various algae, and this action is particularly evident in chlorine-resistant organisms.

Ozone works effectively against viruses and bacteriophages at very low concentrations, tens of mg/l. Under similar disinfection conditions, the polio virus is destroyed by chlorination with 0.5-1 mg/l of residual chlorine in 1.5-2 hours, while by ozonation with 0.05-0.45 mg/l of residual ozone, is destroyed in 2 minutes.

The observations made by a number of water treatment plants using ozone as a disinfectant have shown that in 1 mg/l for 1 minute, the bactericidal effect obtained is satisfactory.In current practice, 0.5-2 mg / l ozone is used for water disinfection. The bactericidal effect is less influenced by pH and temperature than with chlorine. [2]

The criterion for a good disinfection process is the presence of residual ozone within the range of 0.05-0.1 mg/l. Therefore, in the practice of water ozone, it is necessary to introduce ozone quantities to cover the ozone requirement of water, so that the required amount of free ozone remains after the first contact.

For residual ozone levels of 0.013 mg/l, the bactericidal effect was 14.2%; at 0.05 mg/l the bactericidal effect increased to 48.8% and reached 99.7% when the amount of ozone was 0.135 mg/l. [8], [9], [11].

The residual ozone concentration to be ensured depends on the quality of the water. If water is polluted, a residual ozone concentration of 0.1-0.2 mg/l and even 0.4-0.5 mg/l is required in the case of highly polluted waters with organic substances to obtain a bactericidal effect .

Higher contents of organic matter in water require higher ozone consumptions. If the water contains great quantities of organic substances, they consume quickly large amounts of ozone, so that it remains too small to destroy the germs; In addition, the water also has an unpleasant taste due to the partial oxidation of organic substances.

In any case, the residual ozone concentration should not exceed 5 mg/l, because exceeding this limit would impart the characteristic odor and taste to the water. Others, however, consider that excess ozone spontaneously disappears from the water, with no inconvenience to water quality.

Ozone precipitates iron and manganese salts, being used as a method of removing them from water; it also oxidizes the nitrites it turns into nitrates.

Ozone is a dangerous substance for humans, even in small concerts. The maximum ozone concentration permitted in breathable air is 0.1 ppm.

Recent water research shows that water disinfection by ozonation has capital costs, running costs, high maintenance costs, and high hazards, and that ozone-depleted water promotes cancer.

Advantages of potable water treatment with ozone:

-requires less reaction time (10 minutes versus 30 minutes for chlorine);

-bactericidal activity is 20 times stronger;

-is not influenced by the pH of the water;

-does not persist in the water and does not produce any residual products (oxygen is released);

-does not produce chlorophenols and does not otherwise affect the taste.

Disadvantages:

-it has no lasting, remanent effect on the network;

-efficiency is affected in the presence of organic substances that "compete" with the bacteria they should attack;

-produces toxic compounds such as ozonides, hard to dose.

3. RESEARCH ON IMPROVING DRINKING WATER QUALITY USING OZONE TREATMENT

There are two types of basic technologies used in ozonizing water, whether the purpose is to obtain drinking water:

- ozonization in a free-flow reaction tower;
- ozonisation under pressure with ejector system

The second variant is the selection option due to the high efficiency and reduced volume of the technological installations.

This technology is applied by large companies, experienced in the treatment of ozone water. Among these are: Ozonair (USA), DEL (USA), Degremont (France), Astral Pools (SPAIN), and others.

One of the treatment variants used is that of a slip stream which aims to treat ozone only a percentage of the recycled water (6-20%) with an ozone dose of max. 1 g ozone / m3.

Advanced oxidation processes not only provide excellent disinfection but largely eliminate undesirable organic substances, precursors of unwanted by-products. These processes allow integration into an automated control system, minimizing the possible risks that may arise during operation.

Ozone is a more powerful disinfectant than chlorine and UV radiation, destroying bacteria and viruses. Ozone is obtained from the air with controlled electric discharge.

Biological effects of ozone are:

- the disinfecting and trophic action mediates direct local application;
- antibacterial and systemic antiviral effect due to discrete peroxide formation.

Consumption of ozonized water contributes to maintaining or improving health. By its action of activating blood microcirculation and increased oxygen intake, ozonized water improves the functions of all organs.

Thus, by slightly alkaline pH it contributes to the decrease of gastric acidity, its detoxification capacity eliminates toxins accumulated in the liver and kidneys. Also

ozonized water regulates the secretion of endocrine glands and improves metabolism, dyspepsia, diabetes and migraines.

Ozone is obtained by passing an air current between two high voltage electrodes (10000-20000 V), where electrical discharges occur. The ozone concentration in the air is 2-3 grams / m3.

In order to disinfect 1 m3 of filtered water, 0.5-5 g ozone is required. Because of the low solubility, only 70% of the ozone produced is used for disinfection - (low efficiency). By treating food with ozonized water, the food gets a natural taste.

Experimental results are presented below:

Limits of maximum admitted concentrations and scale from which some effects are perceived by humans are shown in Table 1 and graphically in Figure 1.

Table 1. Maximum permitted ozone concentrations

Maximum permitted ozone concentrations, CMA, mg/m^3			
Protected areas		Working areas	
0,1	0,2	0,03	0,1

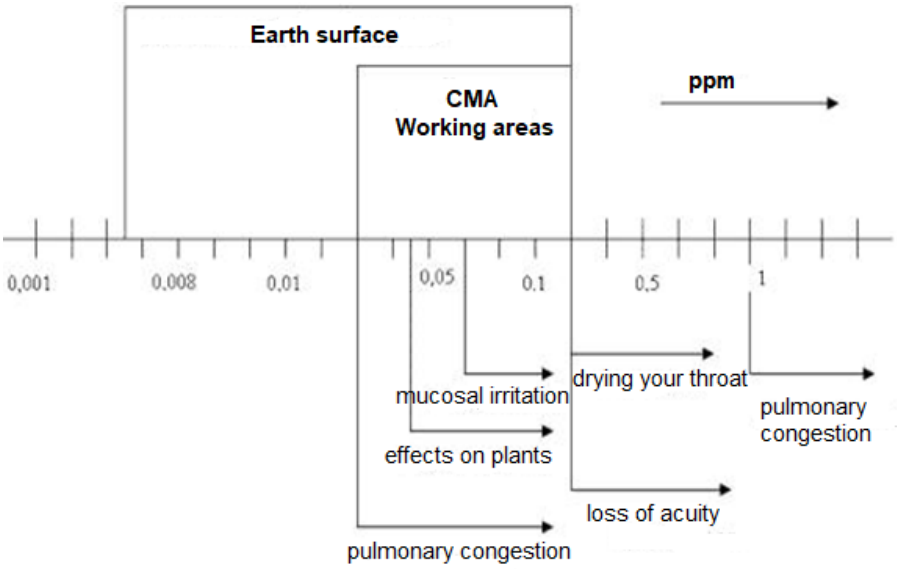

Fig. 1. Limits of maximum admitted concentrations and scale from which some effects are felt by humans

The experiments performed followed two distinct lines:

- determining the optimum operating parameters of the equipment;
- assessment of disinfection efficiency.

A maximum ozone concentration at the 4-5 kHz frequency range was highlighted.

The graphs in Figures 2 and 3 comprise the equilibration and relaxation curves (after shutting down the equipment) at a supply voltage frequency of 5 kHz.

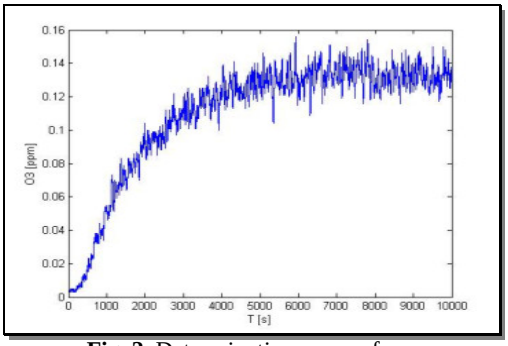

Fig. 2. Determination curve of equilibrium concentration

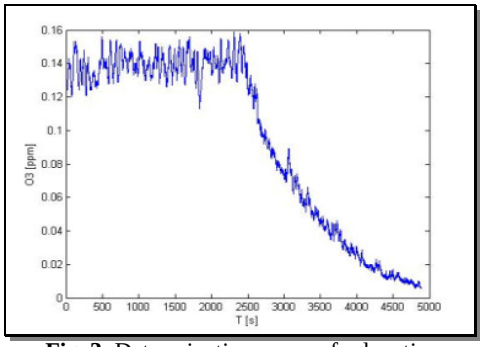

Fig. 3. Determination curve of relaxation concentration

Microbiological determinations by constituent categories are presented in Figures 4,5 and 6. Microbiological parameters were analyzed during the four seasons (8 samples p1 ... p8), determining the value of the parameters analyzed before and after water treatment with ozone.

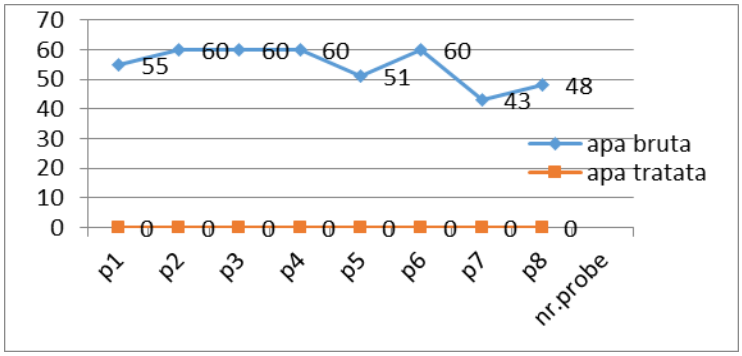

Fig. 4. Variation of total coliform bacteria (No. / 100ml water)

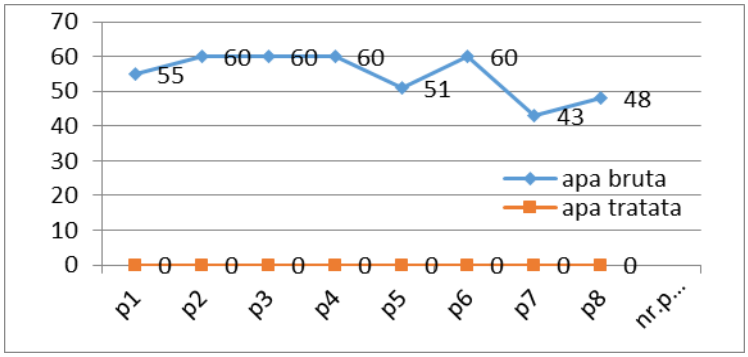

Fig. 5. Variation of Eschirechia coli (No. / 100ml water)

Total coliform bacteria

Total coliform bacteria are microorganisms present in the environment whose presence in water can cause disease. Their presence in the water composition is a risk factor only in case of exceeding the maximum admissible values established by the legislation and the public health norms.

For total coliform bacteria, law no. 458/2002 on the quality of drinking water provides for this parameter to be absent. Figure 4 shows the variation of this microbiological parameter before and after treating the water under analysis with ozone.

Escherichia coli

Escherichia coli (E. coli) is a bacteria that can cause serious infections. Many types or species of Escherichia coli usually live in the digestive tract of humans and animals.(C.Bădulescu,2015)

Some species, however, produce a strong toxin that causes blood diarrhea and rarely can cause serious haematological problems and even kidney failure. The most common type of E. coli is E. coli O157: H7. Escherichia coli is a lactose-positive (decomposing lactose), gram-negative, oxidase-negative bacteria that appears on a rod-shaped microscope.

It is part of the group of enterobacteria that live as epiphytes in the digestive tract. In some cases of intestinal microflora imbalance, these bacteria can cause disease by massive multiplication or the emergence of toxicogenic strains.

For Escherichia coli, Law no. 458/2002 on the quality of drinking water provides for it to be absent.

Figure 5 shows the variation of this microbiological parameter before and after treating the water under analysis with ozone.

Enterococci intestinal

Intestinal enterococci are microorganisms present in the environment, whose presence in water can cause water illness.

For intestinal enterococci, law no. 458/2002 on the quality of drinking water provides for the absence. Figure 6 shows the variation of this microbiological parameter before and after treating the water under analysis with ozone.

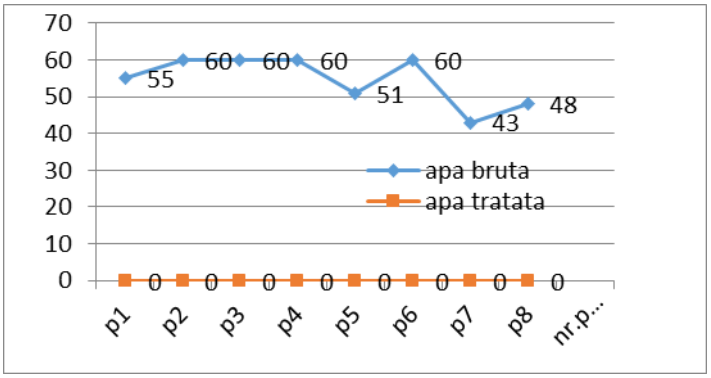

Fig. 6. Variation of Intestinal Enterococci

4. CONCLUSIONS

In our country, as everywhere in the world, specialists' efforts are directed towards finding solutions that help to increase the safety of water, taking into account the direct relationship between water quality and health.

Another major problem of the element indispensable to life, namely water, are the quality conditions imposed by Law 458/2002 amended and supplemented by Law 311/2004. With Romania's accession to the EU, these quality conditions are much more rigorous and must be strictly respected, so treatment methods, distribution network, etc. need to be improved.

By comparing disinfection techniques through the cost of operation, installation, maintenance, control system, disinfection performance, hazards, water effects, we find that the ozone treatment method is expensive but also efficient.

Microbiological determinations carried out on microbiological constituents of ozone-treated raw water have highlighted that all parameters analyzed: Escherichia coli, intestinal enterococci, total coliform bacteria are within the legal limits allowed by CMA.

Ozone is a chemically efficient but costly method of investment and operation of the plant, requiring high electricity consumption. Ozone has a strong oxidizing effect on microorganisms and also acts on the taste, smell and color (transparency) of water.

Disinfection of water with ozone is less useable due to the complicated and costly installation, and because of the high operating cost (high electricity consumption) compared to chlorine water disinfection. Ozone is widely applied in France.

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THE IMPACT OF DEINDUSTRIALIZATION AFTER 1990 ON DEMOGRAPHY AND HUMAN HABITAT OF PETROŞANI DEPRESSION

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Abstract: *The Petrosani Depression, considered to be the most important exponent of the hard coal mining industry in Romania, represents today an area characterized by serious social and economic problems. The economy of this region still depends strongly on the mining industry, which makes the other sectors underdeveloped. The failure of the restructuring process from the Petrosani Depression generated a series of serious consequences such as the reduction of the employed population, to which is added the difficulty of finding a new job, either due to the low supply of jobs compared to the demand, or due to the technical specialization of mining employees, which limited their employment opportunities in other economic sectors.*

Keywords: mining, deindustrialization, Petrosani, demography, human habitat.

1. GEOGRAPHIC FEATURES AND HIGHLIGHTS OF THE FIRST YEARS OF INDUSTRIALIZATION

The Petroşani Depression is located on the West Jiu and East Jiu rivers, it has a triangular shape, elongated on the SW-NE direction, with a width that varies between 15 km near the village of Campul lui Neag and 25 km near the Tirici village in the Petrila town [1, 6]. The territory is crossed by the meridian of 23^0 East longitude, in the Western end and the parallel of $45^020'$ North latitude (Uricani town). Petrosani Depression is also called "Jiu Valley" and is a small region consisting of three municipalities: Petrosani, Lupeni, Vulcan and three cities: Petrila, Uricani, Aninoasa, with a total population of 120,734 inhabitants, according to the 2011 census.

The first observations made on the coal field in the Petrosani Depression were recorded in 1782, when it ignited in the outcrop areas and burned for a long time, the

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observation being made by the mineralogist Benko Janoş. But the first prospecting works in the true sense of the word began in 1835 when large coal reserves are highlighted [4]. From 1840 the interest for the riches of the basement of the Jiu Valley increases; the pioneers of mining in this area are members of the Hoffman family, the owners of the capital of the Rusca-Montană iron mines and Carol Madespach.

The deposit was initially exploited only to satisfy local requirements. Based on the property of Hoffman Rafael, in 1883 the Coal Mining Company of Jiu was founded, a company that made simple operations in Lupeni area and which was in competition with the mining possessions of the Austro-Hungarian monarchy.

The process of training the employees was accentuated in the Jiu Valley in the second half of the 19th century, the mining job being a new task. For the beginning period, the main source of skilled workers was the colonization within the Austro-Hungarian Empire, and only over a period of 30 years, the Petrosani depression has seen a population increase of over 225% [2]. Thus, after the 1869 census, the Petrosani depression had 12,672 inhabitants, in 1880 it had 16,000, in 1890 it had 18,705, of which 13,764 Romanians, and in 1900 their number had reached 28,698, of which about 15,000 were Romanians. According to the statistics published by the Hungarian company in 1900, it turns out that out of the total number of 1,394 workers, over 43% were actual miners, 9.4% assistant miners, and 23% wagons workers.

The acceleration of the economic development, of the communication ways, the widening of the internal and external market have led more and more to the rapid increase of the demand for fuel, so that the Petrosani Depression has been involved in the economic life of Transylvania, leaving deep traces and benefiting in the economic situation of the inhabitants from this area.

Over time, the process of coal extraction has developed, transforming the Petrosani Depression from an area where animal breeding was the predominant activity of the inhabitants, to an industrial area, where, at the beginning of 1990, over 50,000 people were engaged.

After 1991, the oil production increased, almost constantly, until 1997. The decrease of the oil demand, from 7.1 mil. tonnes in 1997, to below 3 mil. tonnes, after 2001, due to the restructuring of the Romanian industry, led to the mining of the Petrosani Depression and the inclusion of depression in the category of urban areas with a decline industry, in which mining became unprofitable. For the Petrosani Depression the exploitation of coal meant the justification of its existence; if we consider only the personnel of the mining operations, in the period 1990-1996 about 20% of the population was employed in such enterprises. Adding to this staff and that of the auxiliary units, then the share of those who were actually employed in the mining system reaches up to almost a third.

Since 1997, the mining industry in the Petrosani Depression has entered into a restructuring process, a process that is still ongoing and for which, in this sector of activity, approx. 6,000 people.

2. THE IMPACT OF DEINDUSTRIALIZATION ON HUMAN DEMOGRAPHY AND HABITAT.

The Petrosani Depression, considered to be the most important exponent of the hard coal mining industry in Romania, represents today an area characterized by serious social and economic problems. The economy of this region still depends strongly on the mining industry, which makes the other sectors underdeveloped.

The social and economic situation in the Jiu Valley has suffered due to the massive layoffs of staff, since 1997, when they left the system over 20,000 employees (45% of the staff) (table no.1). None of the implemented programs, in an attempt to mitigate the effects of the redundancies, have had the expected effects, and the social conditions are far behind the requirements of the period in which we are.

Table 1. Resident population evolution of Petroşani Depression between 1967, 1992, 2002 and 2011

No.	**Period / Town**	**1967**	**1992**	**2002**	**2011**
1	Petroşani	37.539	52.390	45.195	37.160
2	Petrila	7.238	29.302	25.840	22.692
3	Aninoasa	6.751	5.368	5.106	4.360
4	Vulcan	21.964	34.524	29.740	24.160
5	Lupeni	29.377	32.853	30.642	23.390
6	Uricani	7.661	11.845	10.227	8.972
Total Petrosani Depression		**110.530**	**166.282**	**146.750**	**120.734**

One of the relevant indicators of the life quality of a population is the structure of food consumption. Studies show that in the Petroşani Depression, except for bread, less than 50% of families daily consume products such as fish, vegetables, meat, milk and products derived from milk or meat, fruit, eggs or juices. In the case of fish or white meat products, consumption is the lowest, about 62% of the population declaring that this product is consumed less than once every three weeks. There is an orientation towards the consumption of cheaper and more consistent products, at the expense of expensive and healthy ones, which denotes an advanced poverty, the strict problem, which is given priority, being that of physical survival.

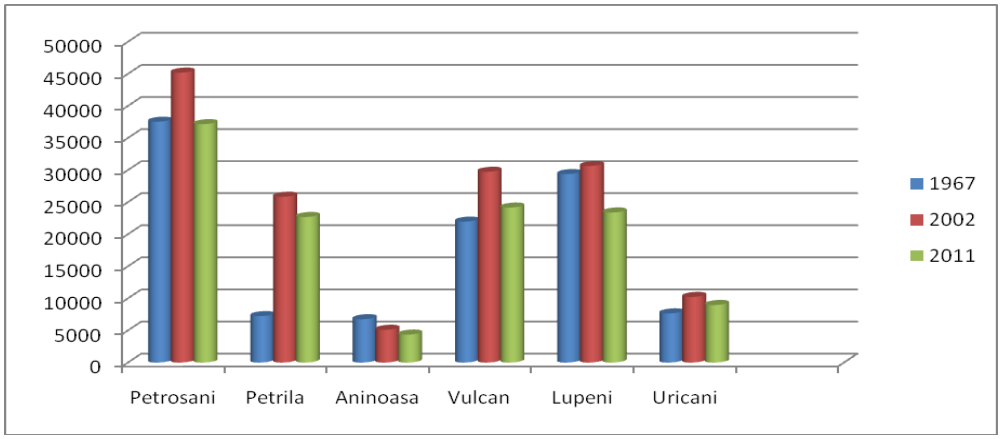

Fig.1. Resident population evolution of Petroșani Depression between 1967, 2002 and 2011

About 78% of the population of the Petroșani Depression has, at this moment, the debts to at least one of the banking and non-banking financial institutions (banks, mutual aid houses etc.), and the debts to the housing associations have the highest rate, meaning that most families have constant maintenance debts.

Although, in this area, 87% of the families live in a block of flats and in most cases the house is a personal one (80%) of a family member, according to the national situation, the residents of the Petroșani Depression live in conditions much poorer than the others due to the living space allocated for a family member, which is much lower than other areas of the country.

Following an analysis of the labor market in the area, it can be seen that the unemployment rate, in the Jiu Valley, reaches much higher levels than the national average (25-30%), which means there is a presence of a large reserve of people in working age (especially women), but who cannot find a job in the area.

The period of economic downturn, which occurred following the restructuring of the mining sector, in the Petroșani Depression, has brought a series of changes in economic and socio-professional level.

Thus, unemployment and work in the lohn type regime had a strong impact on demographic structures, on the criminal phenomenon, it generated a remigration to the native places of the thousands of laid off in the industry, it led to a pollution of the urban landscape [3].

Therefore, it is possible to speak of a real chain of negative effects in the mining sector, each component giving rise to a different effect:

• the decrease of the birth rate - the numerical regression of the population - its aging;

• deindustrialization-unemployment-increase of the crime rate;

• unemployment - migration of population - increase in the number of divorces etc.

Of all the effects of restructuring the mining sector and implicitly that of the related activities, perhaps the most serious was the emergence of unemployment, the

personnel reductions being determined either by the technological outfit of some enterprises, or by the closure of the non-performing ones.

The unemployment situation in the Jiu Valley between 2010 and 2018 is presented in table no. 2. in the form of average values for each analyzed year. A first effect was the numerical regression of the population, followed by an aging of the population. If the 2002 Census recorded 146,750 inhabitants in the Jiu Valley, 120,734 inhabitants were registered in the 2011 census.

Table 2. Unemployment situation in the Jiu Valley between 2010 and 2018 (average rate)

No.	**Years / Town**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
1	Petroşani	1500	1131	1213	1393	1314	1460	1037
2	Petrila	1225	515	562	626	634	791	652
3	Aninoasa*	237	152	-	-	-	-	-
4	Vulcan	1351	594	660	743	729	695	602
5	Lupeni	1042	666	744	748	708	615	623
6	Uricani*	262	174	-	-	-	-	-
Total		**5617**	**3232**	**3179**	**3510**	**3385**	**3561**	**2914**

A phenomenon generated by the restructuring of the Jiu Valley industry that has existed before, but in the opposite direction, is population migration. If until 1990, the Jiu Valley, functioned as a real attraction for the population in the eastern and southern counties of the country, with the fall of the local economy, the surplus of population was reoriented to other areas of the country, where the achievement of a stable income was relatively easy, or even abroad [2].

To minimize the negative effects of this phenomenon of population migration and to meet the training needs, through the vocational training procedure, a procedure that aims to increase and diversify professional competences, in order to initiate, qualify, retrain, improve and specialize people, in search of a job, having as a final objective, the achievement of mobility and (re) integration in the labor market, with the help of the Vocational Training Centers, training courses were organized, courses that were carried out over different periods of time, depending on the complexity of the training and the need existing on the labor market.

As a result, after 1997 several vocational training courses were organized and graduated, which could provide qualified personnel in the expected activities to be carried out as alternatives to mining. Following the qualifications in the table we find their insufficiency, from the point of view of the professions, for the proposed activities. The Jiu Valley will still remain dependent on the mining activity, both

through the level of employment directly and indirectly, as well as through the resources to be attracted by this activity.

Therefore, it is necessary that the actions to aim at the continuation of the restructuring process of the mining activity, correlated with activities meant to ensure the development of a private sector capable of taking over, by transfer, a part of the available labor force from the mining activity and not only.

3. CONCLUSIONS

The Jiu Valley, considered to be the most important exponent of the hard coal mining industry in Romania, represents today an area characterized by serious economic and social problems. The economy of the Petroşani Depression is still strongly dependent on the mining industry, which makes the other sectors underdeveloped.

The failure of the restructuring process from the Petrosani Depression generated a series of serious consequences such as the reduction of the employed population, to which is added the difficulty of finding a new job, either due to the low supply of jobs compared to the demand, or due to the technical specialization of mining employees, which limited their employment opportunities in other economic sectors.

None of the implemented programs, in an attempt to mitigate the effects of the personnel layoffs, had the expected effects, and the social conditions are far behind the requirements of the period in which we are.

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THE CHALLENGE OF CLIMATE CHANGE ON THE ENERGY ECONOMY OF THE EUROPEAN UNION

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Abstract: *The climate has always been variable, but today there is a growing concern over climate change issues, perhaps because the magnitude of the change seems to be unprecedented but, more importantly, because some scientists say that there is a strong evidence to suggest that humanity might be directly responsible for climate change. Any change in climate would lead to destabilization of environmental and social conditions in Europe and all around the globe. These disturbances could jeopardize the conservation of natural ecosystems and sustainability of social and economic systems. The EU faces major challenges from the increased threats of climate change, with serious consequences in the energy sector, where urgent issues are arising concerning the national production mix of each member state.*

Keywords: climate, climate change, energy source, economy, environment, European Union.

1. INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) was established under the auspices of the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to assess, compile and synthesize scientific, technical and socio-economic information relevant to our comprehension of climate change, its potential impacts, and outline options for adaptation and mitigation. The periodic Assessment Reports of the IPCC constitute the best synthesis of the state of our knowledge of climate change.

The IPCC also develops possible scenarios for anthropogenic emissions in order to project future climate trends. Depending on these scenarios, climate models project that by 2100 atmospheric CO_2 concentrations will reach 540 to 970 ppm. The global average surface temperature is projected to increase by 1.4 °C to 5.8 °C over the period 1990 to 2100.

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Global sea level is projected to rise by 0.09 m to 0.88 m between 1990 and 2100. Global average water vapour concentration and precipitation are projected to increase during the twenty-first century, and larger year-to-year variations in precipitation are very likely over most areas where an increase in mean precipitation is projected [2]. Changes in extreme and/or severe weather events such as heat waves, droughts, extreme precipitations, severe tropical cyclones, can also be expected.

Europe's climate has been warming by about 1 °C in the last century, higher than the global average. Rainfall amounts have increased considerably in northern Europe, while drought periods have become more frequent in the south of the continent. Recently recorded extreme temperatures, such as the heat wave of summer 2003 and especially 2007, have been linked to the observed increase in frequency of extreme phenomena in recent decades, as a consequence of the effects of climate change. [4] Although single meteorological phenomena cannot be attributed to a single cause, statistical analyzes have shown that the risk of such phenomena has increased considerably due to the effects of climate change [3].

The latest scientific evidence suggest that the increase in global mean temperature is likely to exceed the 2° C and target the 4 °C to 6 °C by the end of the 21st century. Furthermore, most of Europe is expected to warm more than the average global warming in the 21st century. The potential environmental, economic and social impacts of such high-end warming scenarios has drawn the attention of the scientific community, which has a crucial role in advising future policy making [1].

2. ISSUES RELATED TO ENERGY SOURCES LIKE BIOMASS AND BIOFUELS

The energy challenges of the EU are complex, a fact determined both by the relationships established between the energy dimension of security and other aspects of it, from the internal as well as the global context, the reduction of fossil fuel deposits, the dependence on external suppliers and the impact of using these fuels on the climate.

The European energy policy decisively leads to an economy characterized by reduced conventional energy consumption, safer, more competitive and more sustainable. The energy objectives to be achieved with priority are to guarantee a competitive functioning of the internal energy market, security of strategic supply, a concrete reduction of greenhouse gas emissions caused by the production or consumption of energy, as well as of affirming the EU as a unitary voice on the international stage [5].

Dependence on gas and oil imports is one of the central issues to which the European Union must find an answer. The long-term solution of the energy problem is not to find new suppliers, to discover new sources, to consolidate and build the related infrastructure, but to identify intelligent solutions for hydrocarbons consumption and new energy sources.

A key aspect of the energy dimension of European security relates to renewable energy sources. These sources are at the intersection of several internal security concerns at EU level. First of all, these resources are about energy security. The identification of alternatives for fossil fuels (nuclear, wind, solar, thermal, hydroelectric, geothermal) could be a solution to reduce the EU's dependence on imported gas [6].

The EU has begun a strategy to diversify sources of supply to meet its energy needs. The development of biofuels and biomass could contribute to this goal. However, it must be borne in mind that biofuel development strategies could have a negative impact on the environment and biodiversity. Expected expansion of biofuels from biomass hides several potential risks:

- high amount of water if the basic material is maize;
- water pollution;
- soil erosion due to a concentration in certain regions with minimal agronomic concerns;
- failure to comply with the rules regarding the presence of pesticide residues;
- rising commodity prices to the extent that this expansion would lead to speculative movements in future markets.

Climate change and the potential depletion of conventional energy sources have led to a new approach by using biofuels. They are obtained from renewable resources, ie from a raw material that can be permanently restored.

A permanent source of energy is represented by plants containing carbohydrates or polyglucides. One such plant is corn. Animal breeders know that corn contains a lot of starch. It is transformed by the animal that consumes it into energy which, if it exceeds the needs of the body, is stored in the form of adipose tissue. Starch can be converted by enzymes into glucose, which is fermented by the microorganism in ethanol. So here's another way to harness the energy stored in corn, which is to turn it into ethanol. It can be mixed with gasoline and burned in engines.

In addition to corn, other vegetable products are also used to obtain biofuels: sugar beet, soybean, rapeseed, or even oils from restaurants after roasting food. Animal fats are also a renewable source of biofuels.

Biomass is the raw material for biofuels. Their purpose is to reduce pollutant emissions and reduce CO_2 in the atmosphere. The wider use of alternative sources will result in the shift from fossil fuels to renewable energy sources, which will lead to a reduction in greenhouse gas emissions.

For an efficient management of renewable energy sources it is recommended:

- increasing biodiversity within farms by introducing new crops;
- use of annual or perennial weeds with high energy value (reed, herbaceous plants such as wheat grass and sorghum);
- collection, storage and use of residual organic materials from agriculture, food industry and farms, with a high protein content (liquid waste, domestic and waste water, feed residues, crop residues, slaughter residues);

• increasing the share of crops destined for biogas production (corn, sugar beet, rapeseed);

• installation of solar panels to heat water and enclosures;

• construction of wind farms in areas with constant wind intensification;

• the installation of small hydroelectric power stations that can use the flowing water flows within a farm;

• installation of mini-plants that convert the mechanical energy of the water into electrical energy;

• avoiding the burning of vegetable residues in the field;

• cultivation of woody crops with short rotation period (willows, poplars);

• the production of energy briquettes using wood scraps and herbaceous plants and their use for the production of energy by combustion.

3. ECONOMIC CHALLENGES FOR MEMBER STATES

The EU faces major challenges from the increased threats of climate change, with serious consequences in the energy sector, where urgent issues are arising concerning the national production mix of each member state. The renewable energy share needs to be increased and energy efficiency needs to be improved. In order to prevent dangerous climate change, the EU is working to reduce the GHG emissions, at the same time encouraging other nations and regions to do the same. The EU, which is responsible for approximately 10% of global GHG emissions, is playing a leading role with regard to the shift to an economy with net-zero GHG emissions. In recent decades it has managed to decouple GHG emissions from economic growth in Europe, through better energy efficiency, policies for a transition to other forms of fuel and the penetration of renewable energy sources, which have had a major effect on reducing these emissions.

Changes in energy consumption are more significant across member states than it is at the EU level. Deindustrialisation has been more prominent in the Northern Europe than elsewhere, generating a simultaneous growth in services which has contributed to a small land lagged increase in energy consumption. At the same time, the greatest efficiency gains were achieved in Eastern Europe when industrial activities underwent modernisation.

In the EU, economic growth contributed to an average of 2.2% increase in overall energy consumption per year from 1990 to 2000 and only 1.2% per year since 2000. Combining structural effects and measures taken to improve energy efficiency resulted in an average decrease of 1.7% in energy consumption per year from 1990 to 2000 and a 1.6% decrease per year thereafter, hence resulting in a small negative rate in energy consumption since 2000. This shows that a change in economic growth has more of an impact on energy consumption than the implementation of efficiency measures. Moreover, this combined effect shows opposite dynamics between structure, such as deindustrialisation and energy efficiency.

In 2013, the European Commission adopted an EU strategy on adaptation to climate change which aims at making Europe more climate resilient. It promotes greater coordination and information sharing between member states and fosters the main streaming of adaptation into all relevant EU policies. The adaptation strategy calls for all member states to adopt national plans to cope with the inevitable impacts of climate change by 2017. By 2018, 25 member states have already developed adaptation strategies (except Bulgaria, Croatia and Latvia). These strategies include measures such as using less water, adapting building regulations, building flood fences, developing crops that cope better in drought conditions.

Under the Multiannual Financial Framework (MFF) 2014-2020, at least 20% of the EU's budget, as much as 206 billion EUR, should be spent on protecting the climate. Climate financing has been integrated in most EU actions, including cohesion, agriculture, external aid, energy and transport.

In 2018 the European Commission proposed a new MFF for the 2021-2027 period with a budget of 1134.6 billion EUR, fully tailored to the EU's priority policies. The proposed budget combines new instruments with modernised programmes with the aim of meeting challenges such as climate change, with 25% of its expediture going towards that aim [10].

Two of the programmes in the financial framework deserve to be mentioned specifically. The Horizon Europe programme, with a total budget of 97.6 billion EUR, is a research and innovation programme and a driver of economic growth and jobs. Its aim will be to support EU policies such as the transition to a low-carbon economy, the protection of the environment and climate actions. In addition, the LIFE programme, with an allocation of 5.4 billion, is the programme for the environment and climate action. It focuses on developing and implementing innovative ways to respond to environmental and climate challenges, such as the transition to clean energy.

Based on studies, Lithuania is the most affected European country by the climate change, where as Iceland is the least affected. The three European countries that have been most and least affected by climate change are (figure 1):

- Lithuania has been seeing a significantly high rise in sea levels compared to the other European countries that were a part of the study, with an increase of 4.46 mm per year between 1970 and 2015. The sea temperature in Lithuania has increased by 0.73 °C, from 1960 to 2014, sharing the first place with five other countries. The surface temperature has increased the most, with an increase of 0.325 °C per decade, again sharing the first place with six other countries. Finally, the precipitation in Lithuania has increased by 20 mm per decade, between 1960 and 2015. All indicators considered, Lithuania ended up with a total score of 75.04.
- Finland, the surface temperature in Finland increased by 0.314 °C per decade, whereas precipitation saw the exact same increase of 20 mm per decade, as in Lithuania. Furthermore, the sea temperature in Finland has increased by 0.73 °C, from 1970 to 2015, whereas the sea level has seen a decrease of 4.26 mm per year. However, according to the National Land Survey of Finland, new land has been appearing from the sea for centuries due to the Fennoscandian land uplift. It might, therefore, be

difficult to determine the extent to which the sea level drop in Finland has been caused by climate change. After combining the different indicators, Finland ended up with a total score of 72.96.

- Latvia, the data showed very similar results to Lithuania, with three of the indicators ending up with the exact same score. The only indicator where Latvia had a lower score than Lithuania is the rise in sea levels. However, compared to most other European countries, Latvia has still seen a high rise in sea levels, with an increase of 4.02 mm per year between 1970 and 2015. All indicators considered, Latvia ended up with a total score of 72.82.

The three European countries least affected by climate change are:

- Iceland. According to the study, Iceland turned out to be the European country that has been affected by climate change the least. Iceland saw an average change in surface temperatures, with a 0.275 °C increase per decade. Compared to the other European countries in our study, Iceland has seen by far the lowest increase in sea temperatures, with a slight increase of 0.208 °C, from 1960 to 2014 - being significantly lower than the European average of 0.621 °C, as well as the global average of 0.327 °C. Additionally, sea levels have increased by 1.31 mm per year, from 1970 to 2015, which is 0.71 mm lower than the European average. Finally, precipitation in Iceland has been increasing significantly compared to other European countries. Their precipitation increased by 35 mm per decade, between 1960 and 2015, whereas the average precipitation in Europe, in fact, decreased by 1.95 mm per decade. After combining these indicators, Iceland ended up with a total score of 36.07.
- Greece. The second country least affected by climate change turned out to be Greece. Greece saw by far the lowest change in surface temperature, with an increase of only 0.075 °C per decade. On the other hand, the Greek seas have become 0.706 °C warmer between 1960 and 2014. This is relatively high compared to many other countries in Europe. Sea levels have seen an increase of 2.01 mm per year, from 1970 to 2015. Finally, precipitation in Greece has been decreasing by 20 mm per decade between 1960 and 2015. These indicators combined have given Greece a total score of 37.15.
- Norway. The third country least affected by climate change is Norway. Out of all the European countries part of the study, Norway saw the highest increase in precipitation, with an increase of 37.14 mm per decade between 1960 and 2015. Just like Iceland, Norway's surface temperature increased by 0.275 °C per decade. Furthermore, sea levels saw a slight rise of 0.25 mm per year, from 1970 to 2015, which is 1.78 mm lower than the European average. Finally, sea temperatures in Norway have been increasing by 0.439 °C per decade, thereby being below the European average. These indicators combined have given Norway a total score of 41.91 [8].

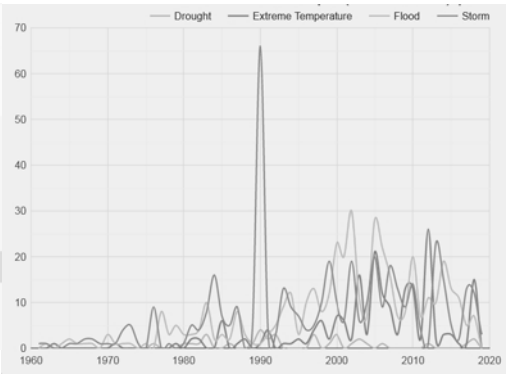

Fig.1. Affected country by climate change **Fig. 2.** Trends in extreme events in EU

The figure 2 shows a tremendous increase in the number of storms around the early 1990, a total of 66 storms in all the selected countries. After 1990, EU saw a lot more extreme events than before, particularly droughts and extreme temperatures.

The EU report on the consequences of global warming on the security environment draws attention to the fact that melting of Arctic ice could exploit the natural gas and oil resources currently locked under the frozen continental shelf. This could lead to divergences between Russia, the United States, Canada, Norway and Denmark.

The trends predicts more upcoming energy challenges and structural changes for the EU economy. In other words, the marginal energy savings from further deindustrialising economic activities in the EU will be increasingly thinner. Similarly, the low hanging fruits of energy efficiency, new motors and waste heat recovery, for example, have already been picked, making future savings less likely.

4. CONCLUSIONS

The long-term evolution of the weather from day to day and from one region to another describes the climate. In turn, the global signal of climate change is projected at very different regional and local scales. The current debates that take place in the international scientific community focus not so much on the existence of this signal, but especially on the uncertainties regarding the magnitude and its regional projections.

Extreme weather events, considered separately, cannot be directly related to climate change (weather and climate being distinct concepts). However, viewed against the background of the observations of the last century, the events of the recent decades are part of a tendency to accentuate the extreme character of some of the meteorological phenomena, a tendency highlighted both by the results of the numerical experiments, in the conditions of increasing the atmospheric concentration of the greenhouse gases, as well as the observations recorded in many regions of the globe.

The EU, which is responsible for approximately 10% of global GHG emissions, is playing a leading role with regard to the shift to an economy with net-

zero GHG emissions. In recent decades it has managed to decouple GHG emissions from economic growth in Europe, through better energy efficiency. The European energy policy decisively leads to an economy characterized by reduced conventional energy consumption, safer, more competitive and more sustainable.

The energy objectives to be achieved with priority are to guarantee a competitive functioning of the internal energy market, security of strategic supply, a concrete reduction of greenhouse gas emissions caused by the production or consumption of energy, as well as of affirming the EU as a unitary voice on the international stage.

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TOURISM POTENTIAL AND DEVELOPMENT MODEL OF STERILE DUMPS FROM PETROȘANI DEPRESSION. CASE STUDY: VULCAN TOWN

CIPRIAN NIMARĂ [1]

Abstract: *Knowing the system's degradation stage at regional level is essential for the strategy design, implementation of the rehabilitation solutions and restoration of the degraded land which must become an integral part of the mining reality. The present paper aims to suggest some ways of functional and aesthetic rehabilitation of sterile dumps within the administrative territory of Petroșani Depression and especially of Vulcan town. The study wants to show the great potential of these anthropic landforms which can be used for tourism development the area.*

Keywords: sterile dump, tourism, rehabilitation, Vulcan, anthropic landscape

1. INTRODUCTION

Vulcan town and its localities Jiu - Paroșeni and Dealu Babii, are located in the southern part of Hunedoara county in Petroșani depression, on the axis of Jiu river, being limited by the two mining basins, Lupeni and Uricani [5]. As mining and related activities have left such a striking footprint on the mining areas of Vulcan and beyond, it is necessary to find solutions specific to each area in part for aesthetic and / or functional reintegration. In order for these solutions to be effective and feasible for implementation in this type of area, it is necessary to take into account its climatic, hydrographic, hydrological and geological characteristics as well as economic and social features.

The term of "ecological rehabilitation" implies more than a simple ecological rehabilitation of the functions that the ecosystem had prior to anthropogenic intervention and which effects were felt on relief, soil, water, microclimate and biodiversity. This term implies a reconstruction of the affected area by its insertion into the environment as well as in the economic circuit [1, 2].

The analyzed areas from the territory of Vulcan municipality present various problems and dysfunctions that make them unusable; the situation being similar in all localities of the Petroșani depression. In order to reuse these lands and/or to eliminate

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the degraded aspect, suitable solutions have to be found according to the climatic characteristics, the land configuration, the social component and, last but not least, the financial situation [4].

2. IDENTIFICATION OF AFFECTED AREAS BY MINING ACTIVITY AND PROPOSAL FOR LANDSCAPE DEVELOPMENT

Mining activities aimed to capitalize the coal deposit and over time have led to a change in the geomorphologic balance in several areas of the locality. These are present as new forms of relief with a strong anthropic aspect that have not been integrated into any conversion program that will transform them aesthetically and functionally [3].

Following the consultation of the General Urban Plan and field work, it has been identified the following affected areas:

- dumping area of Coroieşti coal preparation;
- dumping area of Vulcan mine;
- dumping area of Paroşeni mine;
- mud-setting pond from Coroieşti area;
- mud-setting pond and ash pits from Paroşeni power plant.

2.1. Proposal for landscape development of Vulcan and Paroşeni mining exploitation

In the landscape development process through the forest cultivation of the sterile dumps there are two essential steps to be followed:

- first of all, for efficient and sustainable landscape design, it is necessary to carry out leveling, consolidation and tilting works on the sides of sterile dump to stop any possibility of landslides. Also, given that in the eastern side of Vulcan mine is the Crividia Creek and in the southern one a reservoir of water like a lake, it is recommended to embank the banks to stop the erosion and any land movement.

- secondly, as mentioned above, the Vulcan sterile dump is completely devoid of vegetation, compared to the one from Paroşeni mine, which also highlights the lack of basic soil. There is no basis for sowing in the first stage of grass vegetation, it is advisable to install a thin soil cover of approximately 0,2 - 0,5 m on its surface. Considering that on the sides of Paroseni sterile dump are scattered with appropriate vegetation, it is recommended to install the thin cover of the soil in the spaces between the plants on the sloping surfaces.

With the installation of the soil layer, the sowing and the development of grass vegetation will gradually reduce the degree of infiltration and avoid the formation of acidic waters. Later, different species of trees and shrubs can be planted to increase the degree of stability of the anthropic structure. For normal vegetation development, it is preferable to provide temporary protection by enclosing the dumps.

2.2. Proposal for landscape development of mud-setting pond and ash pits from Paroșeni power plant

This area has several advantages over previous areas, including:

- the configuration of the land surface which is mainly stretched, planted with very few bumps which don't require any consolidation or terraces;
- the vegetation which has been installed and has largely covered the territory, representing a good start for a forest cultivation;

Besides these advantages, the area has also disadvantages and the biggest one is the lack of drainage systems. All water that reaches this area from various sources such as precipitation and torrents that form on the southern slopes, can't leak and therefore becomes puddles, a part being eliminated by evaporation and another by infiltrations.

As these are highlighted, it is necessary to follow a series of processes to combat the problems as follows:

- in the first stage, it is a necessary study of the territory to identify the main stream flows. After identifying them, it will be necessary to choose an efficient drainage method, according to the configuration and the characteristics of the area, from the southern part, respectively from the place where it reaches this area, towards the northern part. These will have a major effect in solving the problems related to the accumulation of water, the flooding in this area;
- the second stage, namely the installation of a thin floor covering of thicknesses between 0.2 - 0.4 m, will be easier to apply in this case, compared to the previous dumps. The area being covered largely by grassy vegetation which helped to form a base soil, it will be necessary to apply the soil only in an insular form on the surfaces that do not have vegetation. Later it will be sown with grassy vegetation. After the area has been uniformed with vegetation, the planting of trees and shrubs will begin, which will help reduce the water in the soil. As in the previous case, it is preferable to temporarily protect the area by fencing.

3. FUNCTIONAL REHABILITATION FOR ADVENTURE TOURISM

The best suited area for such reintegration is the one made up of the sterile dumps belonging to the Coroiești Preparation. In this sense, the main advantage of this area is related to the large area available to be arranged.

As a proposal to reuse this affected area, with relatively low costs of implementation and with high chances of success, it would be the realization of an Off Road Base Camp, on an area of approximately 45 ha, which will host routes for different sports practiced by wheels, like mountain bikes (downhill), motorcycles (motocross), ATVs. Thanks to them, regular activity, competitions, festivals, clubs, etc. could be organized and will attract fans, and not only, both from the country and from abroad. Spaces can be created for different sports, activities and attractions for the audience who will be present, whether they are adrenaline lovers or not.

In the first stage of implementation, it is vital to analyze the access routes to this area and to carry out the works to improve them. In order to facilitate the access in this area I have proposed the creation of a cable car, starting from the area of the Coroiești Preparation until approximately in the center of the area.

3.1 Off road go-carting base

This area will be located approximately in the center and will cover an area of approximately 1.5 ha. The area will contain:

- the rental center that will be equipped with two models of go-carts, one for the track inside the base and the other for the circuit arranged throughout the territory of Off Road Base Camp;
- maintenance and checking workshop for go-carts;
- the track in the base area, intended for those younger than 16 years old, will have a length of about 500 m and a width of 6 m;
- the starting point, arrival and parking of the large circuit;

The go-carts will be equipped with a speed limiter so that ordinary people will run at a maximum speed of 30-35 km/h, and in competitions this speed will be increased to 55-60 km / h.

The circuit will be aimed to those over 16 years old and will have an interesting, diversified route (forest, plains, slopes, streamers, etc.) and with many branches, those wishing to have the possibility to configure the route they want to run. Its length will be about 6.5 km and with a width of 4 m, respectively 5-6 m in curves. There will be competitions for amateurs as well as professionals.

On the route of the track, respectively at the points of intersection and in the more difficult portions, monitoring centers will be located in order to increase the safety and speed of intervention in case of accidents. It will have the opportunity to communicate with each other through the stations, which means that all staff will be informed about the status of the participant and the section of the circuit on which he is. Of course, to diminish the possibilities of exit from the circuit, on the outer edges of the curves will be placed barriers made of rubber or sandbags.

3.2. Motocross track

It will be located on the sterile dump in the eastern part of the area, occupying approximately 3.1 ha of its total.

This area will contain:

- the monitoring center for competitions;
- motocross track approximately 1.2 km long and 12 m wide, with obstacles such as unevenness, hop and ramps;

In this area the portion of the circuit for the cards will be made entirely in the assembly, respectively 1.5-2 m below the land line. In the places where the motocross

track intersects the circuit will be made ramps of about 0.5-1 m, so that their total height will be about 2-3 m (between the circuit and the highest point of the ramps).

The curves of the runway will be raised, so that between the inside and the outside one will be inclined approximately 30°. This operation is necessary to reduce the speed of running in curves and to avoid possible exits outside the track. In dangerous curves, in order to reduce the possibilities of exit outside the runway, you can also opt for the vertical placement of some nets.

The area will be dedicated to training and competitions for professionals.

3.3. Zip line bases

These will comprise two lines, with a length of about 400 m and a vertical difference between the starting point and the arrival point of 50 m, between the 710 and 660 elevations on the lake shore.

Considering that the distance between the starting point and the arrival point is quite large and that a section of the go-cart track passes beside the arrival base on the lake, it can be made available to those who use zip line transport by ATVs or buggies. These should be conducted by personnel engaged in transporting people from the point of arrival to the point of departure. Of course, the zip line cost may, or may not include transportation, depending on your preferences.

3.4. Downhill bike base

It will be located in the southeast of the off road base, near the car cable station. From here will depart two paths with a length of about 700 m and a width of 1 m to the south of the area, which will constitute the downhill routes. The vertical difference between the starting point and the arrival point is approximately 100 m, which highlights a marked inclination of the terrain, to the liking of those who practice this sport.

The location of the base in the vicinity of the car cable station is due to the possibility of returning those who will descend on this route. Specifically, the two paths end in the vicinity of an access road that can be followed by cyclists to the base of the chairlift near the Coroieşti Preparation. In this way they can return to the base.

4. CONCLUSIONS

The analyzed areas from the territory of Vulcan municipality present various problems and dysfunctions that make them unusable, the situation being similar in all localities of Petrosani depression. In order to reuse these lands and / or to eliminate the degraded aspect, suitable solutions must be found in accordance with the climatic characteristics, the land configuration, the social component and not least the financial situation.

Due to the configuration of the surfaces, the location within the administrative territorial unit and the links that these areas have with the center of the locality, in most

cases, it is possible to do only a re-vegetation according to the neighboring areas or a temporary masking with the forest curtains until the activity is completed. However, in our case, the degraded land with the largest area can be functionally redesigned so that no complex intervention on the land is needed. The proposal to set up the Off Road Base Camp can bring countless benefits, both within the locality and within the Petroşani depression, which will offset the closure of mining operations.

Through this paper I wanted to highlight the economic potential of the land within the Vulcan mining perimeter, affected on the one hand by the activities of coal exploitation and storage of the sterile material, but on the other hand the possibilities of its exploitation and the concrete modalities of reintroduction into the economic circuit through adventure tourism activities.

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TOURISM DEVELOPMENT OF MINING LANDSCAPE FROM THE SUBURBAN AREA OF LUPENI TOWN

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Abstract: *The landscape is an important resource, being a remarkable natural and cultural heritage that is appreciated for its beauty and aesthetics, but also its contribution to the identity of a region. Beyond how the landscape sheds light on ways of looking at the world, it also confronts us with the issues of nature and how we relate to it. On the other hand, the urban and industrial development forces us to talk about urban landscape, industrial landscape, or technological landscape. The mining landscape from the periphery of Lupeni town can be a subject of touristic development, taking into account the economic problems of the area and the environmental issues made by the the mining activities through time.*

Keywords: landscape, mining, tourism, sterile dump, Lupeni

1. MAIN FEATURES OF THE LUPENI TOWN

Lupeni town is located in Hunedoara county, at 20 km SW from Petroșani, at 700 m, close to Vâlcan mountains. It has an area of 7.773 ha and 23.390 inhabitants, being considered the third largest town from Petroșani Depression. It borders on the west with Uricani town, on the south with the Gorj county, and in the north, partly with Vulcan town and Baru parish, it is located parallel to the West Jiu river, being guarded by two rows of mountains, which connect the Retezat Mountains with the Parâng Mountains, giving the town an elongated shape [6].

The Lupeni town meets the characteristics of a well-defined geological basin, hydrographic basin and general morphological and geographical depression. According to the shape and position it holds in the relief complex, the municipality of Lupeni, is part of that huge longitudinal corridor, which divides the Southern Carpathians. This is a depression corridor with strong regional accents, which is due not only to the late modeling of the Southern Carpathians, but also to their structure and the tectonic definition of this unit in different geological stages.

Considering the settlement of the localities in the depression, differentiation of the climatic elements will be observed in comparison with other regions. The

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depression character favors the accumulation and stagnation of the cold air, which causes frequent temperature inversions even between the relief units with low altitudes. In summer, the heaters are stronger due to the reduced circulation, so that the daily and annual thermal amplitudes will be different from other regions.

The average annual values of air temperature calculated over a period of 60 years have values of 6.8° C. The monthly average values are between -4.5° C in January and 16.7° C in July, so there is an annual amplitude of 21.2° C. The values of the quite low annual amplitude are due to the frequency of the sea air masses, which in this part is still higher than in other regions, having an open corridor to the west.

The average dates of the first frost appear around October 10, and the frost days disappear after May 1st. The average duration of the annual frost-free interval (days with a minimum temperature above 0° C) is 150 - 159 days.

The absolute humidity of the air, respectively the water vapor, has an annual average value of 6.9, the lowest values being recorded in winter in January, and the highest values, in summer in July.

The variation in altitude of the annual average temperature, the amount of solar radiation and the duration of the vegetation season is also reflected in the specificity of the soil processes.

2. VISUAL ANALYZE OF THE MINING LANDSCAPE FROM THE PERIPHERY OF LUPENI TOWN.

As with any mining operation, the management of the sterile generated by the Lupeni Mining Exploitation has raised some environmental problems. The sterile resulting from the primary extraction and processing of the coal are stored in sterile dumps located in a hilly area, north of Lupeni town, about 2 km from it (Fig 1).

In choosing the site, the aim was to affect a small area of land with a low economic importance. The sterile was transported using the funicular, and the storage has been carried out on three branches (denoted by R1, R2, R3) built in a single bench. Of these, only the southern branch (R3) is currently active, the other two being closed [4].

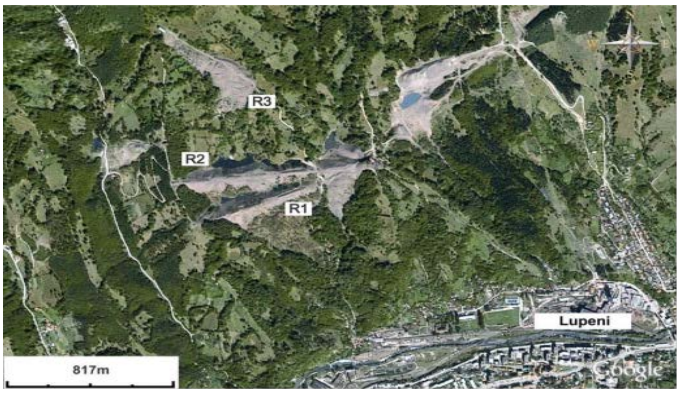

Fig. 1. Sterile dumps from the periphery of Lupeni town, Hunedoara county (source: Google Earth, 2019)

The sizes of the branches vary between 900 m - the R1 branch and 1200 m - the R3 branch, and their heights between 40 and 70 m. The total surface occupied by

the sterile dump is about 34 ha. As a result of the configuration of the deposit, it has exhibited several phenomena of instability over time although at present it is stabilized.

The sterile dumps have an obvious impact on the landscape (being visible both from the city and from the slope opposite to the one on which they are located), the morphology and hydrology (the lifting of the dump bodies allowed the formation of lakes by blocking water courses or by accumulating rainwater) (Fig. 2).

Fig. 2. Lakes near the sterile dumps

Also, the sterile has also changed the state of the ecosystems thus appearing new ecosystems which are poorly developed. They have a high potential for supporting biotic communities and for tourist development [5].

2. PROPOSED MODEL FOR DEVELOPMENT OF THE MINING LANDSCAPE.

Because mining and related activities have left such an important imprint on the landscape of the Lupeni town, it is necessary to find specific solutions for aesthetic and/or functional reintegration. In order for these solutions to be efficient, suitable and capable of being implemented in this type of territory, it is necessary to take into account it climatic, hydrographic, hydrological and geological characteristics, but also economic and social characteristics.

Therefore, in the best case, in order to fade the anthropic imprint it is necessary to design the landscape in such a way that these surfaces are masked with respect to the surroundings until the end of the mining activity, in the case of branch 3.

Afforest of sterile dumps involves two procedures, to reclaim and adapt. This model of reintegration of an anthropic area is applied in most cases, especially when it does not present a potential for economic recovery, due to the low implementation costs.

As a proposal for the correction of the problems that have been installed on these areas and for a more natural aesthetics, considering their neighborhoods, it is recommended to afforest, in order to create a public park, respectively a holiday village. In addition to the functional benefits that such operation brings (providing a

proper microclimate, protection against erosion, regulating the thermal and water regime), there is also the pleasant landscape it creates, in contrast to the current situation. The only disadvantage of this method is the long time required for the development of optimum vegetation and the formation of a vegetative soil substrate.

First of all, for an efficient and sustainable refurbishment it is necessary to perform leveling, consolidation and bank-sloping of the dumps to stop any possibility of producing landslides. With the installation of the soil layer, the sowing and development of grassy vegetation will gradually reduce the degree of infiltration and avoid the formation of acid waters. Later, different species of trees and shrubs can be planted to increase the degree of stability of the anthropic structure. For a normal vegetation development, it is preferred to provide temporary protection by enclosing the sterile dumps.

Green represents the living element and must be considered the protection element that has a significant control role in the image of the suburban territory. The status of a living element also results in its dynamic feature in terms of surface area. Even from the appearance of the urban space, the landscape architecture of the town was largely subject to the natural landscape, as also a similar structure can be found in the contemporary town, altered, however, by the social and economic aspects necessary for the coexistence of the human habitat [1,3].

It appears as an asymmetrical element that occurs in the case of the development of forests in the vicinity of the town. The green is built by parks, as the main elements that must have the following location, in the case of the ideal arrangement of the green spaces:

- the largest park must be located in the center of the citadel;
- smaller parks must be connected to the central one and to the urban habitat structures.

The anthropic degraded land, like the one on which the sterile dumps were deposited in the suburban area of the Lupeni town, can be transformed into useful, safe and functional land through a minimum of "greening", with certain special measures, meant to ensure conditions for vegetation. Why minimum, because, in general, nature has begun to regain the surfaces occupied by humans activities, by the appearance of spontaneous species, but also of perennial species (Fig. 3).

The land recovery should not be related only to the need of improving the lands degraded by the mining activity in order to return to the initial capacity but more to ensure the subsequent use in various other socially and economically functional purposes, constituting as a necessity of modern society (Fig. 4).

Fig. 3. Natural vegetation on the sterile dump

Fig. 4. The proposed model

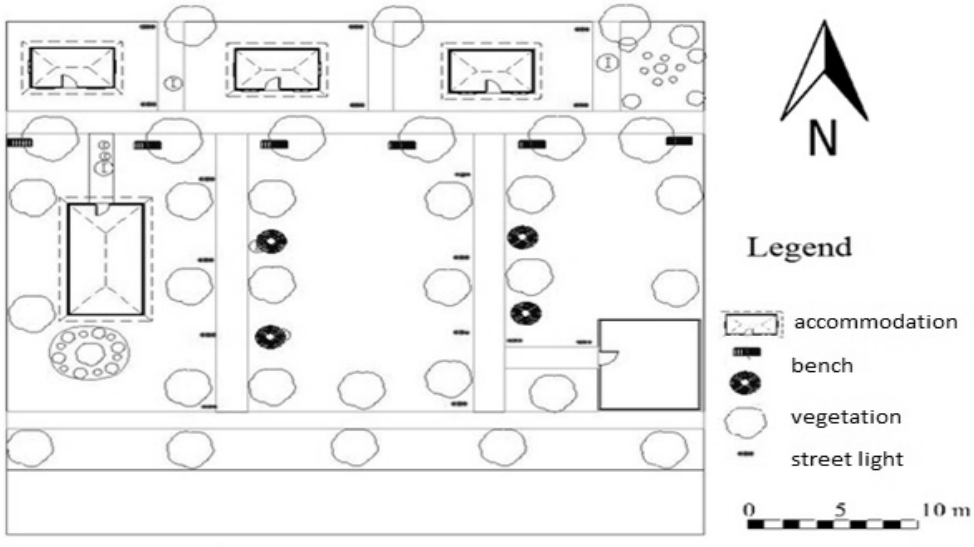

Fig. 5. Blueprint of the touristic village

There so, the proposed model to use these anthropic landforms as a base of tourism development where it can be build a touristic village and park (Fig. 5, Fig. 6).

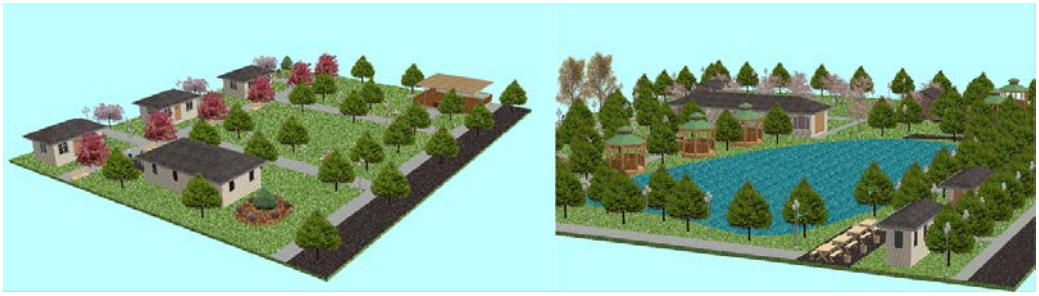

Fig. 6. 3D model of the new landscape

The plantations, the grass lawns, the floral decorations, which make up the created anthropic landscape, want to be integrated into the natural structure of which

they are part. All of these are located in a natural landscape rich in vegetation and harmoniously organized, so that the forms of recreation created do not generate functional conflicts (for example, agitation and noise for those who choose for calm and passive relaxation), contributing to the restoration of energy and psychic tonus, necessary for daily activities [2].

On the old sterile dumps were installed birch trees, and in the erosion zones a natural process of consolidation began with "pioneer" species such as the coltsfoot and the white sea buckthorn. On the slopes predominates the birch tree (the age of the most vigorous specimens being about 9-10 years), also sporadic specimens of hazelnut or ash.

On the upper platform of the dump body, which was leveled at the time when it was active, the degree of cover with grassy vegetation is about 50-60%, sporadic specimens of birch, dog rose and even trembling poplar are encountered.

In accordance with the type of vegetation encountered on the ground, the plant species I propose to continue the vegetation process is in tune with the bottom lines of the landscape that nature has chosen (waist, structure, texture, color), but also based on soil analyzes. These are: birch, sea buckthorn, pine, willow and different species of grassy vegetation. The ornamental species chosen belong to the category of trees with columnar, tabular and plethora form: bush, juniper, thyme, willow and various species of roses. The chosen size is part of category III, namely, trees with the maximum height between 7 and 15 m (table 1).

Table 1. The landscape features of the chosen trees and shrubs

Trees with high ornamental value	**Trees with additional decorative character**	**Height**	**Type of branching**	**Location**
Birch (Betula Alba)	-	III	large	base of the sterile dumps
-	Tuia (Thuja occidentalis)	III	thick	close to the parking area
Japanese cherry (Prunus serrulata)	-	III	large	close to the walkways and cottages
-	Mountain pine (Pinus montana)	III	thick	scattered on the plots
Black pine (Pinus nigra)	-	II	thick	on the sterile dumps and along the access road
Wild pine (Pinus sylvestris)	-	II	thick	on the sterile dumps

-	White sea buckthorn (Hippophae rhamnoides)	III	large	close to the walkways
Red pine (Pinus Banksiana)	-	III	thick	on the sterile dumps
-	Box (Buxus sempervirens)	III	thick	close to the walkways

The afforest of the sterile dumps and the land in their immediate vicinity will be carried out on an area of 7.2 ha, being based on the consideration of the height of tree growth, so as to create a uniformity of structure, form and linearity of the landscape. At the base it is recommended to plant the species of black pine, being followed by red pine and wild pine, at distances of 3 m, 2 m and 1.5 m between trees.

The plastic qualities of small shrubs, as individual pieces, can be used especially in the details of the composition, noticeable nearby: on the banks of the lakes, in the rockery, next to rocks and at the bottom of the stairs. The fine foliage, combined with the more aerated branch, gives to the semi-transparency silhouettes, effects of light and shadow games (birch, larch, red sea buckthorn); the dense foliage, accompanied by a thick branching, determines a strong contouring of the silhouettes, a complete shielding of the vision and accentuated shadows (linden tree, thyme, box).

In this way is obtained a landscape expressiveness, depending on the growth forms. Viewed from a certain distance, the selected elements can be reflected on the grass carpet, on the gloss of the water, on the sky, on the background of other plantations or on built surfaces (facades of buildings). At the same time, the absence of leaves in the cold season makes the tree architecture more prominent, creating remarkable landscape effects.

3. CONCLUSIONS

The "post-industrial land" represents the area used in the past for a certain industrial activity of production, transport or storage which is currently unused or decommissioned and which in the past has played an important role in the economic development of the region.

The mining activity has strongly affected the environmental components of the analyzed area. Despite this, biological, soil and water analyzes showed good quality of terrestrial and aquatic biotic environments. This is due in particular to the relatively high capacity of the sterile dumps to support life forms.

In the absence of the ecological rehabilitation measures, the capacity of the sterile dumps to reintegrate into the natural circuit can be possible by its location in a hilly area, surrounded by well developed forests, but also by the physical, chemical and biological characteristics it has.

The proposed solutions for the landscape reintegration of the suburban area of the Lupeni town have on one hand an aesthetic value, trying to rebuild the degraded landscape after the deposition of the sterile material resulting from the coal exploitation

and on the other hand, to offer a note of social and economic functionality to an anthropic degraded land, which didn't have an increased economic value before. At the same time, through the arrangement of this perimeter for tourism and recreational purposes, forest fruits and handmade items can be sell in the touristic village, in specially arranged stands.

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COMPARATIVE ANALYSIS ON THE PERCEPTION OF PAROŞENI MINE IN MASS MEDIA - PAST AND PRESENT

CREMENE COSMIN SERGIU [1]

Abstract: *The Paroșeni mine was one of the "youngest" mines in the Jiu Valley. This article is the basis on a future extensive research on layoffs and the profiles of miners. Starting in 1949 - 1950, the Jiu Valley mining industry is experiencing a continuous development. Paroşenii - related to history through the four memorable events that shook the realities of Transylvania in 1784, 1818, 1848 and 1850 (with the opening of the coal era), and especially after 1918 you are greeted from a distance by its imposing houses, at that time, with wide fields, in which the road crossing is rarely seen. Paroşeni mine (Hunedoara county) was closed after 51 years of continuous production, following the application of the decision of the European Commission 787/2010, the same program leading to the closure of the mines from Petrila and Uricani.*

Keywords: exploitation; mechanized complex; layoffs; development.

1. INTRODUCTION

The most dramatic process of the current period, in the Jiu Valley, is the closure of the mines, which also happened with the Exploitation of the Paroşeni Mine.

In general, a mining locality was set up against a mine (Uricani, Aninoasa, Petrila, etc.). As the locality had a greater share of population employed as miners, it was more pregnant as a work center [1]

At the beginning of 1930 the population of the Jiu Valley had 66,753 inhabitants, with a density of 60.2 inhabitants per square km. With the end of the global economic crisis, production is gradually recovering, but the level achieved in 1927 is only reached in 1938, but without the contribution of Vulcan.

The Romanian press has an age of about two centuries, the first attempts dating far before the formation of the Romanian national unitary state.

Censorship has also adapted to the rigors of political propaganda. After the brutal reversal of values, in the first period of the "dictatorship of the proletariat",

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when, immediately after 1948, the place of most academically trained intellectuals was taken by activists of "healthy social origin", censorship knew aberrant forms, ideologically unverifiable, but only morally. In fact, the rules of ideological censorship were always relative in the period 1948-1989, experiencing tougher and more superficial periods; apart from general theoretical directives, the list of restrictions is continually changing and - what was most unpleasant- suffered from system-specific secret mania, as well as all the manifestations of the respective regime. It so happened that, many times, not even the journalists themselves knew the taboos of the moment, imposing a harder and more random preventive self-censorship, even the "coming from above". [2]

In the last years of the Ceausescu regime, during the period when a nationalist-communist regime was imposed and the most disgraceful cult of personality, as the permissible idealistic sphere always narrowed, there was also a standardization of the expression, formalizing the mandatory standard forms (like the ones stated by me in the chapter ,,Mina Paroșeni in the past": "Comrade Nicolae Ceauşescu", the general secretary of the party, Nicolae Ceauşescu" what was called later, "the language of wood".

2. RESEARCH AREA AND METHODOLOGY

I chose as a research method the analysis of the documents doing both a direct analysis on the newspapers published during that time period, namely "Red Flag" as well as an indirect analysis (on the meaning, significance), the analyzes made on the mining operations in the Jiu Valley.

The most important advantage of documentary sources is that they present situations and events as they were recorded, in the authors' personal language and without being affected by the guidelines induced by the researcher. Among the disadvantages, we note: the difficulty of locating them and of having access to them, to the rare ones, personal or classified, especially; the fact that they can often be inaccurate, incomplete or simply inauthentic. When written by hand, reading can be a problem, especially if they are old documents. [3]

In the common language, the term "document" has the meaning of an official document, says S. Chelcea. In the sociological sense, however, it is used with the meaning of text or any other object that provides certain information, the image on the targeted populations or domains, data on the social context in which it was built; documents are so specialized (subjectivity) of their authors, says V. Miftode. [4]

Social documents are direct or indirect "traces" of social facts. Starting from these "traces", the sociologist tries to reconstruct the social life, the human relations,

the social processes. ,,Official papers, newspapers and journals, printed books and flyers, posters, photographs, printed tapes, video tapes, daily records, personal diaries, letters, biographies and autobiographies, but also traditional or modern work tools, work products, consumer goods, as well as artistic creation (painting, sculpture, architecture, etc.) are social documents, important sources of information in sociology.[5]

3. CONCEPTUAL DELIMITATIONS

The notion of "mass media" or mass mediums, formed by the Anglo-Saxons by the union of the Latin word medium (which is in the middle and mediates distance relationships) and the word mass (large quantity), it refers not only to the media and the technical means of transmitting the messages (the communication tools), but especially to the massive character of the broadcast messages, while the notion of "mass communication" refers to the whole process of communication "which incorporates what is conveyed, who drives and who receives the messages"[6]

The notion of media or mass media seems less and less appropriate to understand the diversity of media. Usually, this expression means the technical tools that serve to transmit messages between a number of communication professionals and a wide audience. For this reason, for example, the telephone, personal computer or fax cannot be included in the mass media category a priori because, on the one hand, the exchange is based only on two or a small number of people and, on the other, the broadcaster is not necessarily a communication professional. However, it is possible, rightly, to connect through a computer to a communication network with a wider audience.

However, the general view is that the media consists mainly of books, journals, newspapers, posters, cinema, radio and television. But, we repeat, this notion, suitable for the 60s or 70s, has lost its power of attraction today as it diversifies the range of communication tools related to the use of electronics and computing. [7]

According to an analysis made on the closure of the Uricani, Paroşeni and Petrila mining operations in 2013 and started in 2011, which took into account elements of the technical and economic aspects, resulting in the hierarchies on these fields and on the sum total of both (M.E.C.M.A.,2013)

The technical and economic viability indicators taken into account were:

- exploitable coal reserves (their weight, energy content and degree of assurance at the expected operating rate);
- the efficiency of the opening works, in ml./1000 tons open reserve;

- efficiency of active mining works (tones extracted / ml. Active work);
- the volume of open reserves and their weight in the total of open reserves;
- forecasted level of production and energy content of coal;
- productivity of physical labor;
- the unit cost of production;
- the level of expenses per 1000 lei freight production.

Table 1. Viability scores

Viability					
technique		economic		cumulated	
Mining unit	Scores	Mining unit	Scores	Mining unit	Scores
Livezeni	55,0	Vulcan	58,9	Livezeni	108,8
Lonea	50,6	Livezeni	53,8	Vulcan	100,5
Lupeni	49,1	Lupeni	49,8	Lonea	99,2
Vulcan	41,6	Lonea	48,6	Lupeni	98,9
Uricani	21,4	Paroșeni	40,7	Paroșeni	61,5
Paroșeni	20,8	Uricani	22,8	Uricani	44,2
Petrila	16,5	Petrila	17,3	Petrila	33,8

Source: built on the basis of data M.E.C.M.A. of the Closing Plan for accessing the state aid necessary to facilitate the closure of non-competitive coal mines ", 2003, pp.11-12

Regarding the duration of the closure of a mine, it is in principle 24 months, a term that can be exceeded under certain conditions.

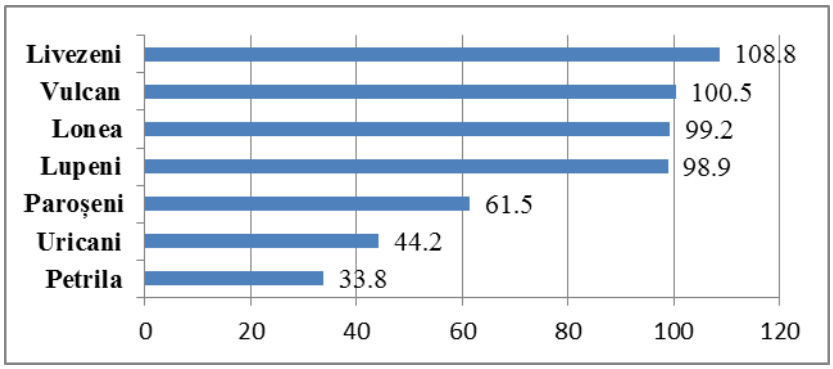

Fig.1 Total viability scores (technical + economic)

As a result, the closure of the Petrila mine was scheduled for April 1, 2015, and the closure of the Paroșeni and Uricani mines for the fourth quarter of 2017. This is because the closure may also involve the exploitation of unused capacity, the 3

mines in liquidation delivering in 2018 over 441,000 tons of coal, even in conditions of higher indicators. The calorific value of this coal was 3755 Kcal / kg compared to 3600 predicted, physical production being 131.7% and freight production 129.1%.

At the same time, the expenses per 1000 lei of merchandise were 1632.1 lei, of which the material expenses represented 454.8 lei. We remind the story of Minister Berceanu, it is right that since 1999, about the 6000 lei to 1000 lei the merchandise production, figure found. [8]

4. MINA PAROȘENI IN THE PAST

The first coal mining operations began around 1840 by brothers Hoffmann and Carol Maderspach, owners of gold mines in Rusca Montana.

Dynamics of coal production growth, required by the directives of the 8th and 9th Congress of the Romanian Communist Party, made it necessary to open new mines. Thus, in 1963, mining works began to open the Paroşeni mining field, which in 1964 gave the first tons of coal from opening works. This mine was linked to Vulcan station by a normal railway line, and the road will be connected by a new road and bridge over Jiu. On the site were built and installed the transformation station and the compressor, storage and a modern administrative complex. The well dug at that time for the deep opening of the deposit will be equipped with a modern extraction plant.

Neither the documents kept in the archives, nor the stones carefully placed in museums, nor the legends can do better than the people who have been and are beyond us. Although the Company was one of the youngest of the coal-bearing basin, in 1988, the miners here, "Heroes of the Socialist Labor", had reached a peak of modern technology - total mechanization in abattoirs, continuous flow transport on lanes, direct inter-communicated communication, closed-loop industrial television tracking and organization of the production process.

On October 7, 1966, when the first tone of coal was released, the miners here were greeted with "Good luck", from the general secretary of the party, Nicolae Ceaușescu, who on that occasion wrote the following words in the Honor Book of the mine: ,,At the very beginning of its activity, we wish the young Paroșeni mining team much increase mining work, increasing success in fulfilling the production plan, health and happiness to all".. (Photo 1)

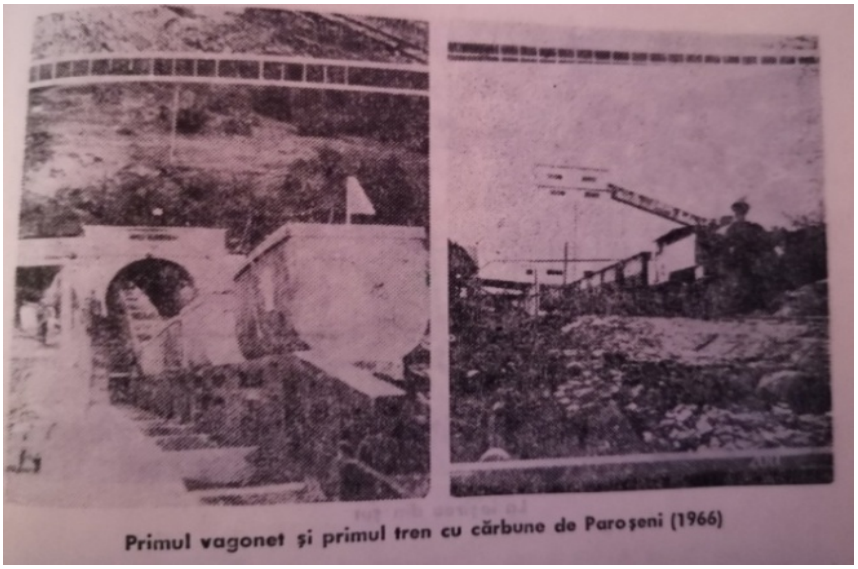

Photo 1 „The first wagon and the first coal train from Paroşeni"[9]

What followed after October 7, 1966, confirms that the modernization of mining marked the beginning of the era for the mining profession. The most modern technique known to the art of mining worldwide has begun to be known and mastered by those who until yesterday did not dare to break it with tradition. The great leap had begun in Paroşeni. The proof: over the years, for the great successes achieved, the hardworking and destitute collective of working people from Paroşeni were conferred by presidential order: Honorary Diploma in the socialist race for the fourth position on the mining branch in 1976; The Labor Order, the second class for occupying the second place in the mining industry in 1977; designation of the company as a model country unit in the coal industry in 1978; Labor Order and Red Flag of Leading Mining Unit on Branch in 1984, 1985 and 1986, culminating in 1987 with the high title of Hero of Socialist Labor.

An article published by "The Red Flag", June 1987, entitled "Broad mobilization for fulfilling economic tasks under high efficiency conditions" - made the results obtained and superior to the achievements recorded by the Brigade led by Ferenc Fazakas, from sector III of I.M. Paroşeni, to be recognized and appreciated at the meeting of the Executive Political Committee of the CC of the PCR, under the chairmanship of Comrade Nicolae Ceauşescu, the Secretary General of the Romanian Communist Party. (Photo 2)


Steagul roşu

Vizita de lucru a tovarăşului NICOLAE CEAUŞESCU în Capitală

În spiritul exigenţelor stabilite de Comitetul Politic Executiv al C. C. al P. C. R.

Amplă mobilizare pentru îndeplinirea sarcinilor economice în condiţii de eficienţă ridicată

RĂSPUNDEREA UNUI BRIGADIER

COMUNISTUL vocaţia de a fi mereu în frunte

Noi utilaje miniere livrate beneficiarilor

„Laudă omului muncii şi creaţiei sale"

„Armonii tinere" o formaţie corală cu adevărat tinără

Photo 2 Red Flag, Year XLIII, no. 10800, June 7, 1987

The first mechanized complex of cutting and supporting - the first in the history of Romanian mining - was introduced in Paroşeni in 1970, in a panel from layer 15. Shortly, another mechanized complex was introduced; During the same period, the first rubber belt conveyors were introduced underground. In 1975, the performance was reached for the entire extracted production to be transported only with conveyor belts with rubber, to the coal storage at horizon 425, where it was mechanically removed with the skip. Thus, during this period, the idea of mechanization was fully and definitively implemented in practice. In addition to the use of important complexes, since 1977 began to be experienced mechanical manufacturing complexes Romanian MAC-1 and MAC-2 with very good performances. Romanian mining equipment industry proved that it can be manufactured in a complex country similar in performance to the foreign. In short, the Romanian complexes of type CMA-5H manufactured by IUM Petroşani and U.M. Timisoara adapted to the specific conditions of the deposit, prove to be superior to similar ones imported up to that date. The productivity obtained through their use proved the triumph of Romanian inventiveness and possibilities.

5. MINA PAROȘENI IN THE PRESENT

Until recently, for hundreds of thousands of years, the "axis of time" was considered linear, as a dynamic in the "one-way direction" of the past, present and future. The past, as a summation of the experiences of humanity, was viewed passively; the present - as the only tangible reality, and the future - as the domain of the unknown, of the unfathomable. [10,p.90]

Until 2018, the dismissed miners benefited from the provisions of Emergency Ordinance 36/2013 regarding the granting of supplementary income, up to 24 months, depending on age. The Emergency Ordinance was in force until 31.12.2018 and has not been extended by another normative act. Basically, the people who have remained unavailable cannot benefit from the money that was granted through EO 36/2013 until last year.

Over 100 miners from Paroşeni and Uricani protested by blocking underground from 28.10.2019 until 7.11.2019, being the longest protest in the mines in the Jiu Valley for the last 15 years. People requesting extension of Ordinance 36, which guarantees them compensatory payments and seniority in work for two years - for those who meet the retirement conditions during this time, as well as the employment at the mines within the Hunedoara Energy Complex for those who cannot yet retire.

At the end of 2019, a number of 141 persons from the Paroşeni Mining Operation were dismissed, of which 7 technical-administrative personnel and 12 persons were taken over by E. M Vulcan and E. M. Lonea. On the surface of the mines, demolition of the existing constructions and the greening of the remaining vacant land will commence, with the operations to be completed by the end of 2020.

6. DIRECTIONS OF SUSTAINABLE DEVELOPMENT AND THE ROLE OF MASS MEDIA IN THESE REGARDS

Despite the measures adopted by the government for the period 2008-2020: reviewing the legislative framework in the mining sector with a view to improving it; the subsidies and assigned transfers, the professional reconversion of the population, the non-reimbursable financing measures allocated to mining areas, the effects of these measures on the members of the community were not expected ones, the reality in this area revealing an increased incidence of social and economic problems of the community. [11,pp.183-184]

Starting from traditional mass media (print media, radio and television) to new media based new information technologies (internet and multimedia), modern means

of mass communication are a fundamental element of human relations with the surrounding world thus new development solutions can be created.

For Dumitru Fodor (2015), the concept of Sustainable Development is the way of preserving, at present and in the future, a high quality of life for the whole society, ensuring the maintenance of the ecological processes that life depends on, provided we continue to use the natural resources we need. [12]

The Jiu Valley will be considered as a single administrative unit, the process of socio-economic and environmental rehabilitation will be managed in a unitary manner and, under these conditions, tradition and the new, with original solutions for sustainable development, are intertwined.

A concept of regional development represents an instrument for regional planning and economic progress, which was applied in particular in Germany in the mid-1990s. The concept of regional development has an informal character, which means that it has no legal effect.

The concepts of regional development pursue a purpose and concern local actors, such as:

- human resources (citizens of a region)
- local administration (decision makers at political level)
- educational facilities (vocational schools, universities)
- the economy of the region (the relevant factors at economic level).
- Development concepts pursue two basic objectives:
- planning and preparation of the higher capitalization of former mining areas (for economic activities, housing, leisure)
- harmonization planes of action, analysis and evaluation of the individual projects meet the needs of a whole.

The elaboration of these concepts is based on:

- analysis of the framework conditions of the site (location, size, history, economic structure, tourist environment, etc.);
- describing the stage of the greening process and establishing the measures that need to be taken;
- elaboration, evaluation and integrated management of the reuse projects taking into account the existing development plans and perspectives at regional and national level;
- establishing a development direction taking into account the characteristics of the area and the future economic structure of the area;

- defining the needs and recommendations of action, among others, connecting to a general tourism concept, to achieve a harmonization of interests for the projects planned within the target area, until the intentions of the particular development and marketing of the area.

,,Development can be seen as a process of expanding the real freedoms that people enjoy (...) Development requires the removal of major sources of deprivation of liberty: poverty as tyranny, reduced number of economic opportunities but systematic social deprivation, neglect of public facilities, as well as intolerance or over-involvement of repressive governments".[13,p.19]

7. CONCLUSIONS

As a result of the obtained data, Mass Media represents the solution sought by people to meet their need for permanent communication and information is precisely the raw material for activating any communication process.

The influence of the media is felt both at the level of the individual's personality, as well as at the level of the whole society, through the contribution made to the structuring of the specific value system, when forming social representations or determining the characteristics of political, economic, cultural life.

The content of messages broadcast by the media influences both the way people think and feel, as well as their way of behaving, of acting. The ideas, feelings and attitudes formed under the impact of audiovisual messages are externalized by embedding themselves in gestures and behavioral acts..

As a consequence of the closure of the mines in the Jiu Valley it would be on the population, namely the depopulation.

The Jiu Valley would not be in this situation if the state authorities would carry out viable projects for this area and those who are part of the projects would not waste money on things the community does not need and the money should be managed as if it were theirs and be directed directly to the community, NO! in their pocket! "

The press offers a huge amount of information, but with a very variable degree of fidelity / truthfulness.

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ORGANIZATIONAL AND SOCIOLOGICAL ASPECTS OF GOLD MINING IN APUSENI MOUNTAINS IN ANTIQUITY AND MIDDLE AGE

IOAN-LUCIAN BOLUNDUȚ [1]
CREMENE COSMIN SERGIU [2]
FELICIA ANDRIONI [3]

Abstract: *The history of civilization and of culture is directly associated with the history of production and mining. Mining has always been, as early as in antique times, significant, both in economic and in religious and social life. The greatest gold deposits worldwide were in Apuseni Mountains in Transylvania, deposits generating abusive invasion by various people, who wished to lay hands on the precious resources, the highlight being conquering Dacia by the Roman Empire. The evolution of economic organization and of social development bear the imprints of gold mining, which contributed to the evolution of the society from the Antiquity to the Middle Ages.*

Keywords: gold mining in Antiquity and Middles Ages, mining organization, mining technology, mining and social development.

1. INTRODUCTION

Extraction and processing of useful ores goes alongside with the history of humanity, in view of manufacturing weapons and tools. The first rock used was flint, and in Neolithic copper and gold. In the second millennium BC, bronze is discovered, alloying copper, tin with lead. Bronze tools and weapons are better than copper ones, with higher hardness, and easily proceed by casting. Such objects have been discovered over the entire Romanian territory, being more frequent in Transylvania, where there existed several non-ferrous ore deposits. Numerous treasures and gold objects have been found here, the supposition being that the similar ones found in the south and east side of the Carpathians, belonging to the Bronze Age and the first period of the Iron

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Age, had also been made from the gold extracted and processed in Transylvania.

Probably the exploitation of gold in the Apuseni Mountain started in the 7th century BC, when the Greeks looking for the *Golden Fleece* in Caucasus were diverted to our regions, where there also had been such a *Fleece*. There is no other explanation for the multitude of Greek gold coins, household goods, art works and gold extraction and processing tools, discovered in this area from this period. Some say that the Phoenicians feasted on these resources. In the 6th century the Scythian shepherds had knowledge about the gold in the sand of the rivers, discovered the noble material in the rocks of the mountains, during crossing over the Carpathians with their sheep. They were established in the Mures Valley, becoming famous gold producers. About another group of the Scythians – Agathyrsi – there are written proofs from several ancient authors, beginning with Herodotus. He described the war of the Persian king Darius in the year 514 BC against the Scythians from the north of the Danube, noting that the Agathyrsi lived in the Apuseni Mountain region, good at mining and processing gold ornaments.

The craftsmanship of extracting and processing gold and silver had been transmitted to the Dacians, who neither neglected iron, to manufacture weapons. Starting from the assertions of Vasile Pârvan in *Getica*, it has been believed for quite a long time that the Dacian gold, captured by the Romans had been from river alluvium only. In the period 1999 – 2006, a team of French archaeologists and researchers from Centre National de Recherche Scientifique (CNRS) and Unité Toulousaine d'Archéologie et d'Histoire (UTAH), together with geologists from Cluj-Napoca and München, performed mining archaeology research in very old mining workings at Roşia Montană. On this occasion, wooden mining supports were discovered. C_{14} testing of the wooden samples revealed that the wood found dates back from 295–90 BC, that is 200 – 400 years before Roman conquer! It is thus clearly proven that the Dacians exploited gold from underground at Bucium, at least in the same period.

The Romans seized from the Dacians 165,5 ton gold and 331 ton silver, and in the 165 years of occupation extracted another 500 t gold and 950 t silver. After the Romans' withdrawal from Dacia, the entire course of the social-economic life acquired a rural character. Economy came back to shepherding and extensive agriculture; crafts were set back, acquiring a prominently household character. Mining was no exception either. After the withdrawal of the Romans, mining activity of the locals was limited to the use of metals to manufacture agricultural tools, weapons and household goods. Gold mining in the Apuseni Mountains was probably reduced to the exploitation of alluvium gold and exploitation of poorer seams, next to surface, in which the Romans were not interested. It is hard to believe that the miners that stayed there after the Romans left abandoned their craft, and started shepherding, because agriculture was

not an option anyway. Gold and silver used to be a strong currency in those times, about which we know close to nothing.

2. ORGANIZATION AND SOCIOLOGICAL ASPECTS OF GOLD MINING IN ANTIQUITY.

Gold and silver resources in the Apuseni Mountains were obviously known by the Romans. The only significant gold seams of the Empire in Iberian Peninsula, were depleted, so that the only salvation of the proud empire had been conquering Dacia. Traian was well aware of this, so that everything had been carefully planned, he himself leading the two campaigns of 101 – 102 and 105 – 106. After the conquer, Traian stayed there a couple of months, to organize the province and especially of the gold mining in the Apuseni Mountain. Based on *Lex provinciae* the frontiers of the province and its legal basis, the empyreal domains and the capital (Sarmisegetusa) had been established. The main empyreal domain was the gold one, directly subordinated to the empyreal administration. Its headquarter was at Ampelum and was led by *procurator aurariarum*, which exerted its attributions by means of an administrative apparatus, made up of technicians and officers, having a small number of soldiers as well, for the military protection of the gold area [11]. The procurator was responsible for the efficiency of the mining and collected all direct or indirect revenues of the domain. There also existed the possibility of leasing mines to small entrepreneurs, for at least five years, without renewal possibility. The leasing tax was set by the procurator, with an average value of 4000 sester per year (1 sester=1 gram of silver), that is not too much. Of the most important mines exploited by the Romans in the Apusen Mountain, Bucium, Roşia Montană, Baia de Arieş and Zlatna, can be mentioned, as well as those around Brad.

The workforce initially used by the Romans was the local people living next to the mines, which had been turned into slaves. These were not allowed to move from one place to another, and could be sold or leased out by their masters. In order to increase the gold and silver amount exploited, the Romans brought colonists from Dalmatia and other areas with tradition in mining, to work next to the local population [13]. The Dalmatians were colonized at Rosia Montana and Bucium, called *vicus* and *castellum*, in such a great number that they formed a separate corporation led by Celesenius Constans, who has a funeral stone erected by Opellius governor at Ampelum, where he died [*Corpus Inscriptionum Latinarum, III, 1322*]. As a result of the use of local people and colonists, mining had known a boom in the area, until the year 167, when the first marcomanic war began (167–175). Marcomans were a Germanic tribe, from the family of the suebs and longobards, which started two wars

against the Roman Empire (167–175 and 178–180). In the fall of 167, they reached Ampelum and Alburnus Maior, destroying the mining area and raiding the gold and silver. The aftermath was so terrible that other colonists had to be brought along to exploit the mines. They had been defeated by the governor of Dacia and Upper Moesis, Marcus Claudius Fronto (168–170), who had been erected a statue by the the citizens of Sarmisegetusa, praising his courage [*Corpus Inscriptionum Latinarum, III, 1457*]. The great German historian and archaeologist Theodor Mommsen (1817–1903), specialized in the history of the Roman Empire and the coordinator of the work in 12 volumes *Corpus Inscriptionum Latinarum* considers that the population hided their possessions from the invaders in secret places. Mommsen is right; the same people will do the same a thousand years later, when the barbaric people invaded them [5, 10, 11].

Much written information referring to the organization of mining in the Apuseni Mountains is found on the *waxed tablets* of Roşia Montană, discovered in the old Roman galleries, between 1786 and 1855. These are small wooden planks, tied by two (diptychs) or by three (triptychs) and covered by beeswax, with various texts. 40 tables had been discovered, but only 25 were preserved, four being complete triptychs. They come from the Roman Emperors times Antoninus Pius (138–161) and Marcus Aurelius (161–180), and one comes from Hadrian's time (117–138). The texts of the tablets represent leasing contracts with privates and associations in view of exploitation, selling – buying contracts of slaves, receipts, an annulment act of a funeral college, and a cooking book for a feast of a craftsmen college. Half of the expenses for this feast were for the wine consumed, as in the saying "*Food is for pride, drinks are for the foundation"*

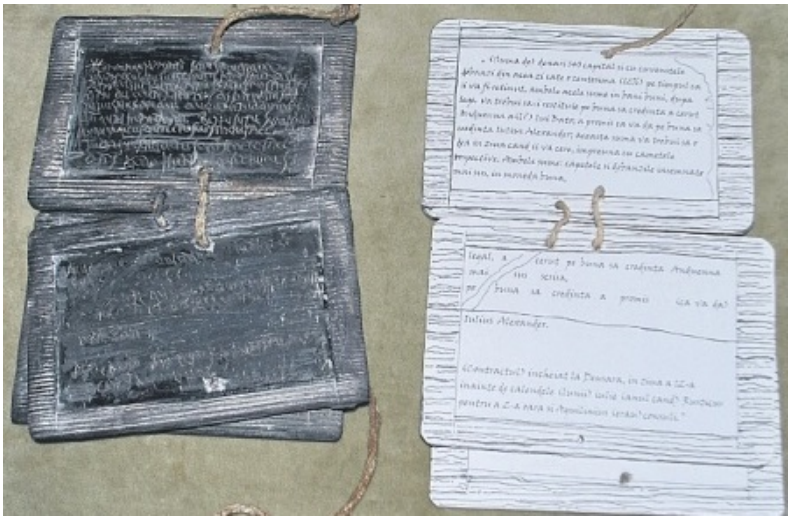


Fig. 1. Bees waxed tablet triptychs closing like a book

3. ORGANIZATION AND SOCIOLOGICAL ASPECTS OF GOLD MINING IN THE MIDDLE AGES

The exploitation of precious metals in the Apuseni Mountains restarts in the 8th century, after the assimilation of the slaves, *Zlatna* toponym being a proof in this sense, which replaced the name of Ampleum, given by the Romans to this ancient mining centre, *zlato* meaning gold in Slavic. There are no documents referring to the social-economic organization of the inhabitants in this area, at that time, but one can assume that they lived according to the inherited customary right. Along with the birth of the pre-state feudal, formations, (duchies and voivodships) the interest for the mining areas increased, they becoming feudal domains, and their inhabitants, serfs of the crown [1, 11]. Over these pre-state formations from within the Carpathian arch, where rudimentary forms of organization started to develop, the Hungarians burst then in. Beginning with the 10th century, the Romanian regions are included in the medieval Kingdom of Hungary, which adopts a colonization policy, colonizing the szeklers in the east, and in the south and in Bistrita region, the Transylvanian Sachs. The colonists' mission was to defend the frontiers and to put to value the economic resources of the autonomous voivodship. Thee conquer of Transylvania by the Hungarians is finished in the year 1210, by subduing Bârsa Land [3].

From this period the first written documents are dated, establishing many aspects of the social-economic life, among which mining. Such a document (*Letter of Privileges*) was given by king Bela the 4th of Hungary (1235–1270), in the year 1255, for the miners of Besztercebánya (Banská–Bystrica of today), by which a series of privileges are granted [2, 4, 12]. The document is important for the Apuseni Mountain mining as well, because from Besztercebánya and from Körmöczbánya German miners were brought to Zlatna and Abrud, who worked in the Bucium gold mines. They kept their privileges granted by Bela the 4th, and had fought for a long time to keep those. From the *Letter of Privileges* from the year 1255, it results that the miners in the said area had certain economic, legal and religious advantages based on which they could have a more sustained economic activity, compared to the rest of the people. They could prospect and exploit noble metals in the subsoil and alluvium, but they had the obligation to pay the royal tax office the 8th part of the gold, the 10th part of the silver extracted, and when metaliferous seams were discovered, the king could take hold of the respective terrain. Similarly, the miners were exempted of the taxes for glassware, and the financial and military obligations to the local gentry. The privileges were acknowledged and reconfirmed by Bela's successors, Ladislau the 4th and (1287) şi Andrei the 2nd (1291). Bela the 4th gave the same privileges to the Sachs from Cricău and Ighiu, by a document of February the 2nd 1238, signed at Architа (today a village

belonding to Vânători, Mureş County), established by the Sachs around the year 1200. The Sachs from Cricău and Ighiu received permission to exploit gold in Zlatna and Vulcoi.

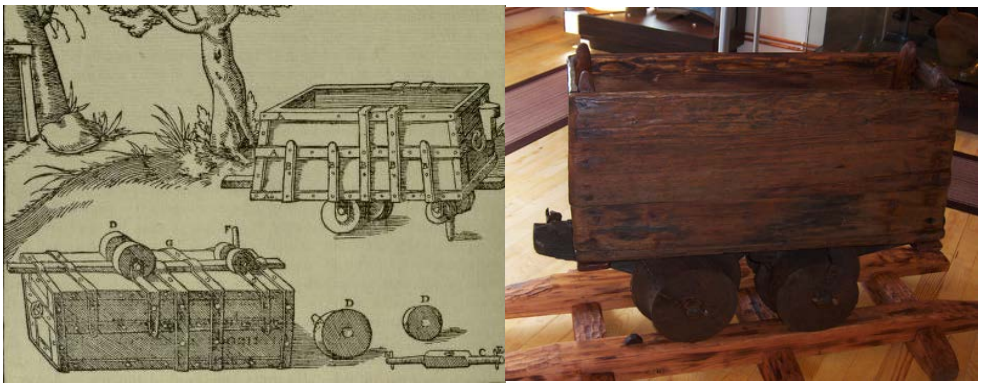
Carol Robert de Anjou was the one that stimulated a real development of mining in Transylvania, by developing a mining Regulation, by a *Letter of Privileges*, signed at Visegrad, in the spring of 1327.

Unlike the privileges granted by Bela, referring only to certain mining communities, those granted by Caro Robers de Anjou referred to all the miners on Hungary's territory. Moreover, the terrains where precious metals were discovered, did not enter in the king's possession, they stayed in the property of the owners, on condition that 2/3 of the contribution to be deposited in the royal treasury, the other third remaining in the possession of the owner. The gold produced in the four mining centres in the Apuseni Mountain, Abrud, Baia de Arieş, Zlatna and Baia de Criş, had to be exchanged at the royal treasury of Sibiu, at the price fixed by the king. Following these incentive measures, gold mining in Apuseni Mountain boosted up, many landowners starting a true campaign of exploitation of the riches of the subsoil. The privileges granted the miners by Carol Robert de Anjou were reconfirmed by Ludovic the 1st of Anjou (1351), Sigismund de Luxemburg (1405), Matei Corvin (1486), Vladislav II Iagello (1492) and Ludovic II Iagello (1523) [10].

Based on these regulations, the steps were taken to organize the operation of the mines. A document from September the 20th 1347, edited by the Chancellery of Hungary for the Baia Mare miners, presents us very interesting data in this sense. Thus, the community of workers, together with the judge and the jurors of the locality where the mine was found (today's mayor and councillors), elected for one year *a skilled magister of the mountain*, (chief of the mine), who was responsible for operation of the mine. He then appointed *steigers* (today's supervisors) and *gold searchers* (today's probers), with the approval of the judge and the jury [6,7,8]. The steigers supervised mine workings and collected the contribution due to the king, and the gold searchers took samples from the faces and established the precious metal content of the ore. The regulation also set up severe punishments for those who did not pay the contribution, but also protected the miners from the iniquities of the leaders.

Interesting data regarding gold mining and noble metal production in Transylvania in the 15th - 16th century come from a report drawn up by Paul Boenemisza (catholic episcope of Veszprém) and Georg Werner, commissioners for king Ferdinand the 1st of Bohemia and Hungary (1526–1564), sent to analyze the concerning situation in which the mines were. In the first has of the 16th century, the gold production in Transylvania decreased significantly. The mined became deeper, and with the methods known at that time it was difficult to evacuate underground water

and the producers did not have the necessary money for the evacuation. The report shows that Transylvania had more gold than silver, and of the four important mines, only Baia de Arieş belonged to the king, and that one mainly exploited silver. Zlatna and Abrud mines, possessing great amounts of gold, belonged to Alba Iulia and the one in Baia de Criş belonged to Şiria, which in its turn belonged to Matei Corvin [2, 9]. Decrease of gold production was also caused by the lack of cash of the Sibiu exchange Office [5]. Clandestine usurers, called *gozari* by the Apuseni Mountain population, used to trade gold, eluding the royal monopole, and making huge profits. Thus, the small gold producers did not significantly come up in the exchange records, although it was them that made the largest gold production. Usually, the gold exchange was granted to the Sibiu Sachs, for 4.000–5.000 Florins per year, sometimes more. At the end of the 15th century, the gold exchange was around 350 kg/year, and in 1552 it dropped to 300 kg. To improve the situation, Transylvania's princes took certain steps, among which reconfirming the old privileges of the mining towns, secularization of the Episcopal lands of Alba Iulia, and introducing foreign capital in gold mining.



a ***b***

Fig. 2. Wooden wagon: ***a*** – according to Agricola; ***b*** – reconstruction

4. CONCLUSIONS

The existing archaeological proofs, artefacts, certain written documents and the studies in the field open the possibility of drawing up a brief descriptive framework of gold mining history in Transylvania, in antiquity and Middle Ages, pointing out aspects illustrating the evolution of the search for gold and its processing in the Carpathian – Danubian – Pontic space, since the Palaeolithic. The former Dacia was enriched with various minerals and

precious gold and silver seams, discovered in Transylvania, Apuseni Mountain. These resources represented a "magnetic attraction" for various migrating people, from the Greeks(the 7th century BC), Phoenicians (6th century), who raided the local gold resources, to the ancient Persians, who according to Herodotus started a war against the Dacian tribes of the Agathyrsi in Apuseni Mountains, to take their gold. The Roman invasions are well known, in their various endeavours to conquer Dacia's gold mines, to the final conquest of Traian, after which no less than 165,5 ton of gold and 331 ton of silver were transported to the Roman Empire, and in the 165 years of occupation another 500 ton of gold and 950 ton of silver had been extracted. In the 165 years of Roman occupation, in the Apuseni Mountain the local mining developed by new extraction methods of the precious metal.

After the Romans' withdrawal, gold mining in the Apuseni Mountain was reduced, probably to the extraction of the alluvium gold from the rivers and to the extraction of gold from the depleted seams, next to the surface that did not seem important to the Romans. In the Middle Ages, precious metal extraction in Apuseni Mountain restarted in the 8th century, and at that time many aspects of the social-economic life and organization and development of mining had been instated.

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THE TITLE OF THE PAPER WILL BE WRITTEN WITH CAPITAL LETTERS, CENTERED, AT 7.0 cm FROM THE UPPER EDGE OF A4 FORMAT, ALONG THE ENTIRE WIDTH, TIMES NEW ROMAN, 14 POINTS, BOLD.

· (14 points)

· (14 points)

The first name and the family name will be written with CAPITAL LETTERS, BOLD, CENTERED, 130 mm width, Times New Roman, 12 points, each name being followed by number, *and in the footnote the didactic and scientific degree, the position and place of work of the authors (possibly fax, E-mail) are indicated, with italics, 130 mm width, Times New Roman, 11 points.*

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<Tab> **Abstract: (Times New Roman, 10 points, bold)** The Abstract will only be in English and will have between 50 and 100 words, arranged all over the entire width, single, left – right alignment, all over the width of the printed space, Times New Roman, 10 points.

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The paper will be edited in a language of international circulation (English, French, German) on A4 format (210 x 297), page setup: top 5,6 cm, bottom 4,6 cm, left 3,7 cm, right 3,7 cm, in WORD or WORDPERFET or WINDOWS and the number of pages must be even between 4 and 16. The size of the symbol is given next and is written in the instructions used to assist in editing the text. It indicates a blank line and does not show in the text of the paper, being obtained by pressing <ENTER>. The size of a <Tab> is 1,27 cm. No blank line is left between the paragraphs. Between the last line before the title and the title of the chapter and between the title and the first next line a blank line is left for each.

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[1] *Professor Eng., Ph.D. at the University of Petroşani, adresa email*

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The text is written in new paragraph and not continuing the subtitle, an 11 point blank line being left between the subtitle and the following text.

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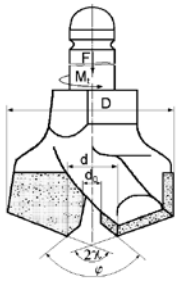

Fig. 1. Detachable bit

Figures should be enclosed in the text in the order of their presentation, as far as possible on the page where reference is made to them. They shall be numbered with Arabic numbers. Black – and – white, high contrast figures are recommended. Photos can be used as well, but they should be of good quality, clarity and sufficient contrast. The figures will have a legend (name of the figure), which, along with the number, will be written underneath with Times New Roman, 10 points, centered as to the figure. The figures will be surrounded by text.

· (11 points)

3. PRESENTATION OF THE TABLES

· (11 points)

The tables will be enclosed in the text, a 10 points blank line being left above and under the table, and will be numbered with Arabic numbers. Both the number and the explanations to the table are written with Times New Roman, 10 points, italic, for the number and bold for the explanation to the table, centered in the space of the table and above it. The table entries will be Times New Roman, 10 points, bold, and the data in the table will be Times New Roman, 10 points. The thin lines of the table will be ½ points (0,02 cm), and the thick ones will be ¾ … 1 points (0,03 … 0,04 cm).

· (11 points)

4. PRESENTATION OF THE MATHEMATICAL EQUATIONS

· **(**11 points)

The mathematical equations will be with times New Roman, 11 points, center of the page and numbered on the right with Arabic numbers between round brackets.

· (8 points)<Blank line 8 point high>

$$X^2 + Y^2 = Z^2 \qquad (1)$$

· (8 points) < Blank line 8 point high>

An 8 point high blank line is left between the last line before the relation and the relation and between the latter and the next first line.

The last page will be at least 2/3 full.

The pages of the paper will only be numbered by a pencil outside the printing space.

· (11 points)

REFERENCES (will be written according to the model, Times New Roman 10 points).

· (10 points)

[1]. **Marian I.,** *Mecanizarea în minerit*, Editura Tehnică, Bucureşti, 1969.

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