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MINING DESIGN BASED ON A DIGITAL TERRAIN AND DEPOSIT BODY MODEL AT TISMANA OPEN PIT

DUMITRU-FILIP TIVIG *
ILIE ROTUNJANU **
ADRIAN FLOREA **
COSTIN-SEBASTIAN MANU *

Abstract: *This paper presents the advantages of mining planning and design based on digital model open pit (land and deposit body) using software. Generally, this specialized software for mining are intended for use by specialized technical staff (mining staff, land surveyors and geological staff), each has a dedicated module of the software. Through the land surveyor module the digital terrain model will be created, through the use of the module dedicated to geology will get the body deposit and not last, is presented the mining module through which the planning and pit design can be done. The paper concludes with an example of mine planning design in Tismana open pit.*

Keywords: *body deposit,open pit, mining, digital terrain model*

1. INTRODUCTION

Mining for mineral resources was done since ancient times in open pit mines and underground mining. In the last hundred years, because of the advancement in technological development and advancement of operation methods, open pit mining has gained a high efficiency and productivity. Surface mines are more advantageous than those underground, economical resources requiring is smaller and the production capacities is comparable, producing over 75% of world production of useful minerals.

With the advancement of computer technology and emergence of the electronic computer, it started the development of applications (software programs for mining domain either surface or underground). Next, we talk about the development of application software for surface mining.

These specialized software should is addressed to a specialized staff composed of a mining engineer, surveyor and geologist. Each of them have a separate module dedicated. The surveyor was able to create digital terrain model, geologist create digital model of the deposit and mining engineer is able to use both in such a way as to be

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able to schedule and estimate production of useful minerals, and not least to be able to see the evolution over time of the mine surface. Next will be presented on short the way of working by using the Surpac.

Surpac is one of the most common programming software for geology and mining works in open pits, this application provides effective use three-dimensional graphics and workflow automation for data processing. Surpac addresses all the requirements of geologists, engineers, surveyors and mining engineers in the field and is flexible enough for different methods of operation and types of deposit. Surpac contains tools that can make data management of drilling, geological modeling of the deposit modeling for earth blocks, geostatistics, mining planning, resource estimation, etc. Surpac is a modular application easily adapted to our needs. Surpac reduces the likelihood of data duplication and can export files while specific areas of GIS and CAD.

2. CREATION OF A DIGITAL TERRAIN MODEL

Before we start to create the digital terrain model we must collect data (perform surveying, photogrammetric measurements, collecting data stored in analog format, etc.) with which we can extrapolate a model exactly as the land area of interest is presented. Creating digital terrain model in general is the task of the professionals in topography; they are the ones who will update the database in time, with the advance of slopes in surface mining. Surveying software module for specialized staff can upload information from several types of digital files. An example would be taking files from CAD (Computer Aided Design) (fig. 1 a) and another example would be the file type Microsoft Office Excel where they are stored in a table format in which each point has an identifier and spatial coordinates (X, Y, Z) and as the case may be, a description (fig. 1b).

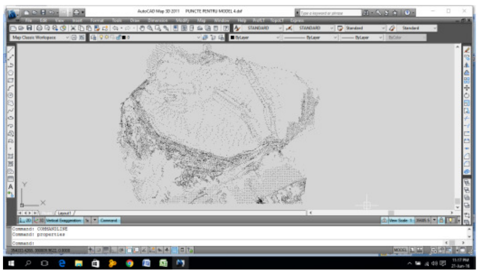
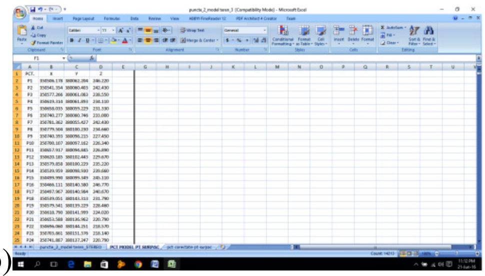
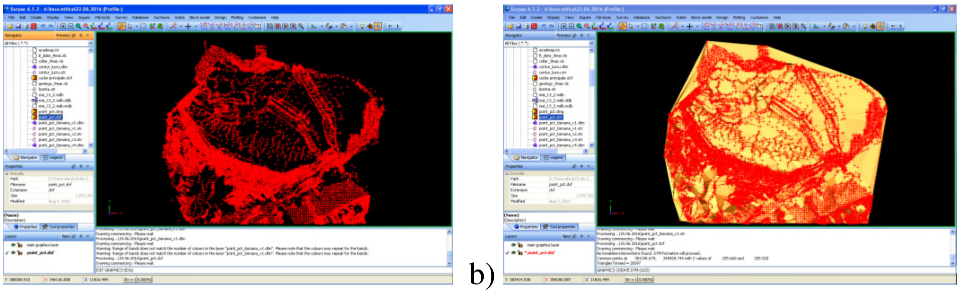
a)  b) 

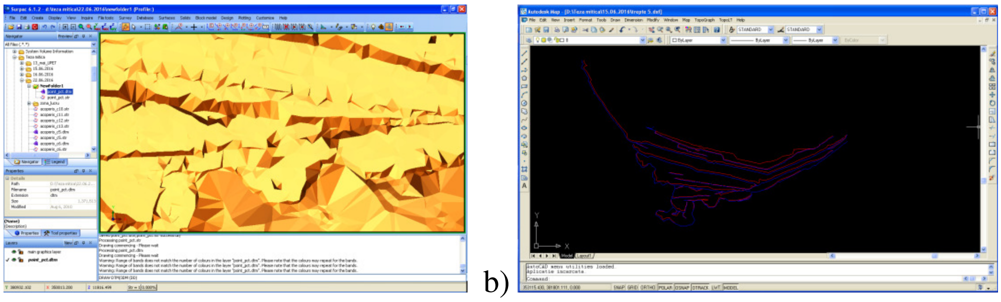
Figure 1. (a) Example of converted data in tabular form in the CAD drawing; (b) Example of table with coordinates converted to digital format MS Excel



a) b)

Figure 2. DXF file import in Surpac application; (b) Digital Terrain Model

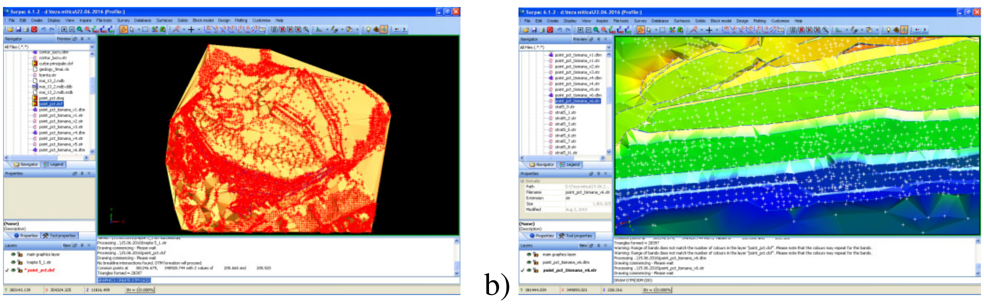
To create a digital terrain model a DXF file is imported into Surpac describing the points of interest (can be seen in Figure 2 a) and the digital terrain model (as seen in Figure 2 b) can be generated. However, as can be seen the generated model doesn't represent the reality on the ground in some areas and to correct this situation it is necessary to introduce break lines.



a) b)

Figure 3. (a) Detail Area of the digital model; (b) Viewing forced slope change lines in CAD applications

After entering in the computer program of new constraints, we could generate a digital terrain model representing more accurately the reality on the ground (according to the data collected in advance).



a) b)

Figure 4. (a) Digital terrain model with break lines; (b) Digital terrain model with break lines (viewing excavation steps)

In Figure 4 a) and b) can be seen a digital terrain model that accurately represents the excavation area. We will also save the resulting data in a file type and in the same time .dtm will be created and file of the same name .str containing textual data with which we can recreate digital model ever.

3. CREATING DIGITAL MODEL OF THE DEPOSIT

To create the digital model of the deposit (the ore body deposit) is necessary to collect geological data in the field. Geologist or any legal source for such technical operations does up to date geological data collection. It takes data from direct mapping of slopes already open in open pit mines, and if there are no open pit mines in the area of interest, the date necessary is collected by performing exploration drilling (Fig. 5a and 5b), with which the stratigraphic column describe the ore body in our area of interest.

a) 

b) 

Figure 5. (a) Drilling plant; (b) Stratigraphic column - obtained from core drilling

Geologist will do the description of these lithological and stratigraphical samples (cores) that were recovered from the drilling. The description of drill holes will be stored can be tabular or graphic (drawn pad) be it analogical or digital describing the structure and composition of the subsoil respectively. The number of geological drilling holes required to describe in detail and accurately the structure and composition of the subsoil in area of interest is determined depending on the arising situations in which there are differences compared to existing data.

Before converting analogue geological data in digital format, we must choose the form and structure under which we will convert this data. For this, we must choose specialized software for our industry because each application has accepted the form and structure of data that can be processed. This application can retrieve information from various databases, for this project we will use the Microsoft Access database type.

Geological structure databases (MS Access) for application Surpac contains several tables (Fig. 6) including the following: collar, geology, survey, etc. These tables refer to information obtained from drillings in our area of interest (in Figure 6b can see an example of information contained in the table collar).

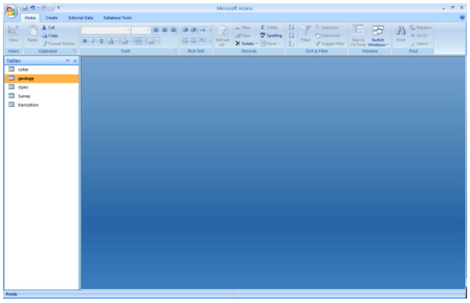
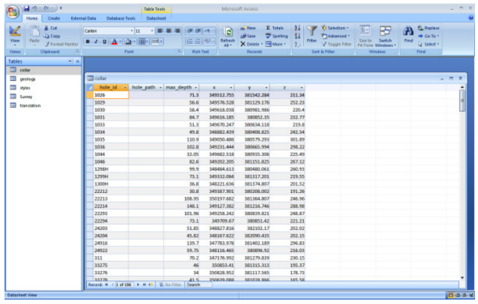
a)  b) 

Figure 6. (a) Geological database that contains tables collar, geology, styles, survey, translation; (b) Example with information in the table Collar geological database

To create the digital model of the ore body deposit is required to access the geological database with Surpac, after which we can display and extract different information (Figure 7 a and b) with which we can create digital model of the ore body deposit (if we talk about our deposit is lignite coal). In general, coal deposits are in the form of layers of various sizes (thickness).

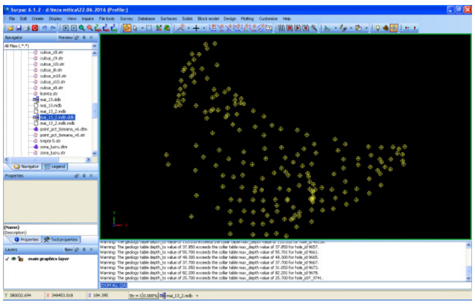
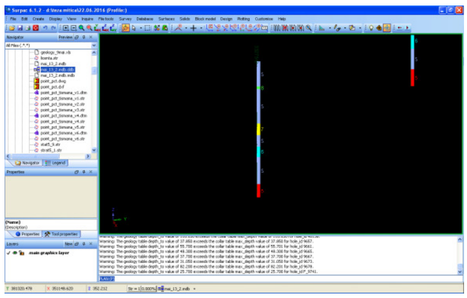
a)  b) 

Figure 7. (a) Drilling holes from the database; (b) Lithological column and labels represented according to data set in the database

To create the digital model of the deposit (in our case we speak of multilayered coal deposit) we need to extract from the database top (upper part of the deposit) and bottom (lower part deposit) for each coal seam of the deposit that lies in our area of interest. Based on this data representing the top or the bottom of coal seams we can create a surface that will represent the top and another to represent the bottom, through the union of the two surfaces will result in a solid object that defines each coal seam. We will validate in Surpac these solid objects and will result the volume of our coal deposit in our area of interest.

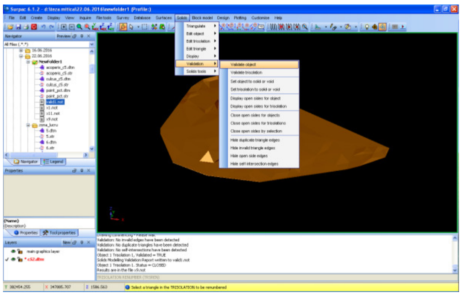
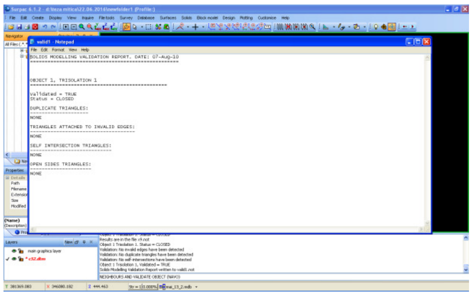
a)  b) 

Figure 8. (a) The solid object representing the coal seam of our ore deposit; (b) Object validation and obtaining the volume of the coal seam from our deposit

The process it will be applied for all seams in the area of interest, ultimately resulting the digital model of the coal deposit.

4. PLANNING AND DESIGN FOR BUCKET WHEEL EXCAVATOR E1400-07 IN TISMANA QUARRY

For this goal, we chose an area in which it will be illustrate the working procedure in which we plan and design the area to be excavated.

The bucket wheel excavator E1400-07 (Figure 9 a and b) working in the area of elevation 180-150 (high bench) and 150-140 (under the bench, below the transport conveyor belt) (Figure 9 c).

a)  b) 

c)

Figure 9. (a) and (b) E1400-07 bucket wheel excavator; (c) below the transport conveyor elevation 150-140

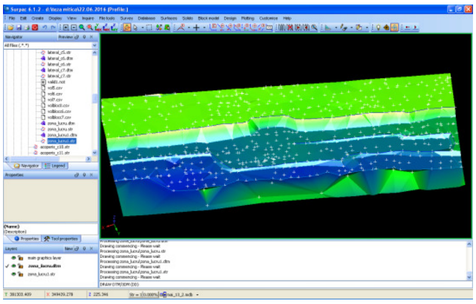
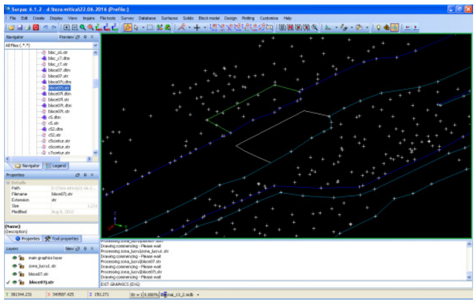
a)  b) 

Figure 10. (a) Work area cut from the digital terrain model; (b) Draw the top and bottom of the block excavation

To facilitate processing of the data will crop an area of digital terrain model as you can see in Figure 10 a); using our digital terrain model will draw the top and bottom of the solid object (Figure 10 b) that will represent the volume of the rock mass that can be excavated in a certain time. In Figure 11 a and b can be seen the block excavation and volume reported for it.

Following the report result we see that the block volume is 104 338 cubic meters, we know that the excavator E1400-07 has a capacity of 1100 cubic meters per hour and works 16 hours a day, so this block can be excavated in about 6 days.

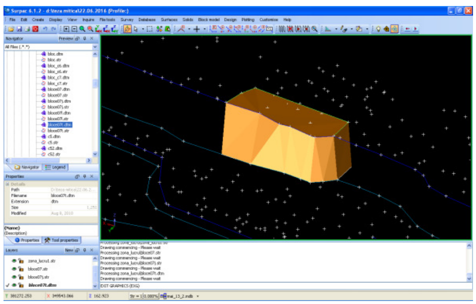
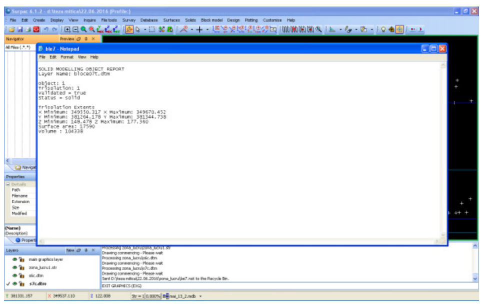
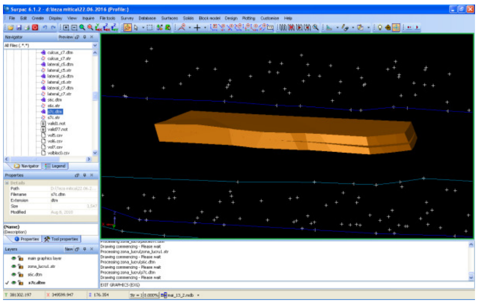
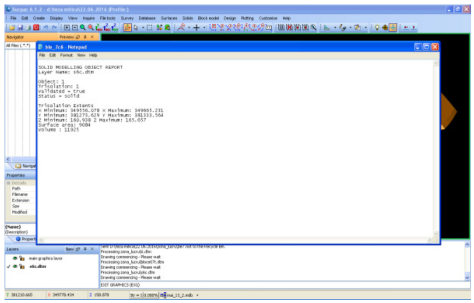
a)  b) 

Figure 11. (a) Block excavation object; (b) Report with the volume calculated for the block excavation

To find the volume of useful minerals that can be extracted from the block excavation, we will intersect the block with digital model of the ore body deposit. Following this procedure will notice that block is intersecting two coal layers (layer 6 and layer 7 of the coal deposit) as can be seen in Figure 12 a).

a) 

b) 

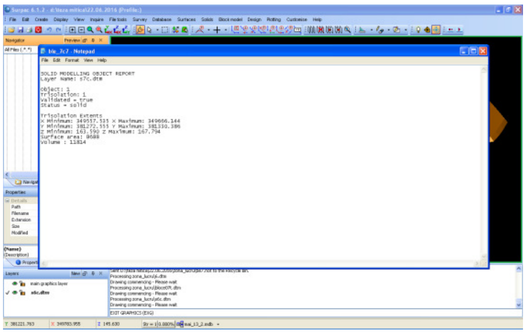
c) 

Figure 12. (a) The shape and position in the bench of the two coal layers (layer 6 and layer 7 coal) after intersection.(b),(c)

The resulting volume report for the ore in the excavation block for layer 6 and layer 7 in the coal deposit. After generation of the report with the volume of coal, we will see the resulting volume of 11925 cubic meters for layer 6 and 11814 cubic meters for layer 7, resulting a total volume of 23739 cubic meters, for the six days we have an average of 3956.5 cubic meters of extracted coal per day of operation.

5. CONCLUSIONS

Following the operations performed above we can draw the following conclusion:

- Accurate estimation of volumes that are to be excavated is easier and closer to reality.
- We can visualize the three-dimensional format for the mining operation, and we can draw conclusions easier on the shape, size.

- We can see the evolution over time of the mine in the future and in the past (if we have information from the beginning of opening the mine until present times).
- We can create multiple scenarios of the evolution in time of operation and can choose the most suitable one.

6. REFERENCES

Aninoiu, D., *Geologia aplicata in carierele de lignit din Oltenia,* S.C. Tipografia PRODCOM, Tg-Jiu, (1997).

Bristol, R., Kumar, K., Jackson, P., *DTM surfaces in Surpac VISION, Surpac Minex GROUP Pty Ltd (a Gemcom Company),* Perth, Western Australia, (2007).

Florea, Adrian, *Pachetele software de proiectare şi planificare minieră – instrumente ale ingineriei mediului.* Revista Minelor 11–12 / 2008, (2008).

Florea, A., *Soluţii pentru excavarea zonelor colinare din bazinul minier Rovinari,* "UNIVERSITARIA SIMPRO 2008", Petroşani, (2008).

Fodor, D., *Exploatarea zăcămintelor de minerale si roci utile prin lucrări la zi,* vol. I, Editura Corvin, Deva, (2008).

Fodor, D., *Exploatarea zăcămintelor de minerale si roci utile prin lucrări la zi*, vol. II, Editura Corvin, Deva, (2008).

Petrescu, I. ş.a., Geologia zăcămintelor de carbuni vol. 2, Editura Tehnica, Bucureşti, (1987).

Richardson, S., Bristol, R., Jackson, P., *Introduction to Surpac VISION, Surpac Minex GROUP Pty Ltd (a Gemcom Company),* Perth, Western Australia, (2006).

William, H., Mark, K., Randall, M., *Open pit mine planning & design Volume 1 - Fundamentals*, 3rd edition, CRC Press, London, (2013).

Scientific Reviewer:
Assoc. Prof. PhD. Eng. Tudor GOLDAN

POSSIBILITIES OF THE PRODUCTION CAPACITY DEVELOPMENT OF THE LONEA COAL MINE, IN VIEW TO INCREASE THE MINING EFFICIENCY

ILIE ONICA*

Abstract: *In order to increase the production capacity of the Lonea mine, Jiu Valley coal basin, a decision was made to achieve an investment program to improve the mine technical and economic performances. For this, it was necessary to develop a very complex study. The works were based on the actual situation of the Lonea mine, and generated certain possible development scenarios to be applied, argued in detail in terms of technical, scientific and economic efficiency.*

Keywords: *mine, coal, production capacity, mining method, mining technology, scenario, economic efficiency*

1. MINING METHODS AND TECHNOLOGIES FOR COAL SEAMS NO. 3 AND 5, LONEA MINE

1.1. General mining of the coal seams no. 3 and 5

Taking into account the geo-mining conditions [5] of the Lonea coal deposit, the following general mining modes of the coal seams no. 3 and 5 were identified [10]:

α) Mining stopping of the coal seam no. 3 and in advance opening, preparing and mining of the coal seam no. 5;

β) Coal seam no.3 mining and opening, preparing and simultaneously mining of the coal seam no.5;

γ) Coal seam no.3 mining and opening, preparing and partial simultaneously mining of the coal seam no.5;

δ) Coal seam no.3 mining and the coal seam no. 5 abandonment mining.

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1.2. Mining methods and technologies for the coal seam no. 5 and 3

1.2.1. Coal seam no. 5 mining

The mining method: retired longwall coal face on strike, with rocks caving roof control (fig.1 - slice no.1) [1];

Mining technology: drilling - blasting coal cutting, individual metallic supports (hydraulic props of 3.15m of height and articulated caps of 1,25m of length) and coal transport with TR-3 armoured conveyor [1].

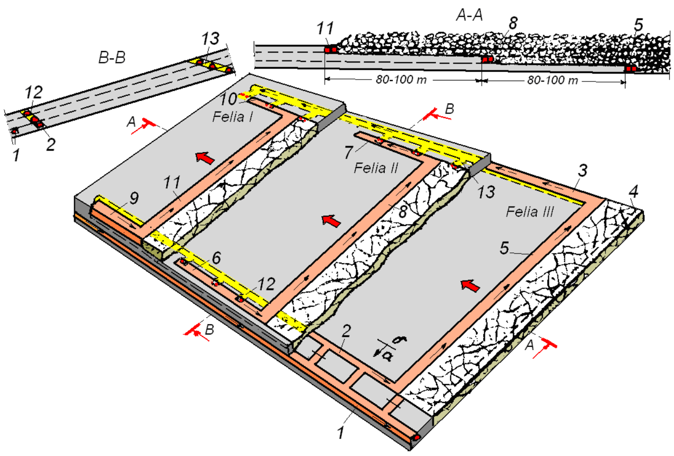

Fig.1. Inclined sliced and retired longwall mining coal face method on the strike, with rocks caving roof control

1, 2 – directionally double-entry, slice III; 3 – directionally ventilation gallery, slice III; 4 – starting inclined working, slice III; 5 – longwall coal face on strike advancing, slice III; 6 / 7- transport / ventilation directionally gallery, slice II; 8 – directionally longwall coal face, slice II; 9 / 10 –transport/ventilation directionally gallery, slice I; 11 - directionally longwall coal face, slice I; 12 - linking slices rise; 13 –linking cross gallery

1.2.2. Coal seam no. 3 mining

1.2.2.1. Variant 1

A) The mining methods and technologies of the *Block II A* (strike size of 140m) and *Block IIIB* (strike size of 178m) are [10]:

a) *Mining method*: longwall face with top coal caving [11] in horizontal slices (7.5m of levels: coal face height of 2.5m and top coal height of 5m) and directionally advancement (fig. 2);

b) Mining technologies with top coal caving [11]:

1. Drilling - blasting coal cutting, individual metallic supports (hydraulic props of 2.5m of height and top coal caving articulated caps of 1.25m length, with spacers) and coal transport with TR-3 armoured conveyor (fig.3);

2. Drilling - blasting coal cutting and frame powered supports (GEROM or Kopex type) and a single TR-3 armoured conveyor;

3. Mechanized coal cutting single drum shearer (ESA-60L, BESA-60L or FCM-120) and frame powered supports (Tau Schafer type) and two armoured conveyors (one at the coal front – for shearer and another one, at the top coal - type TR-3) - fig.4.

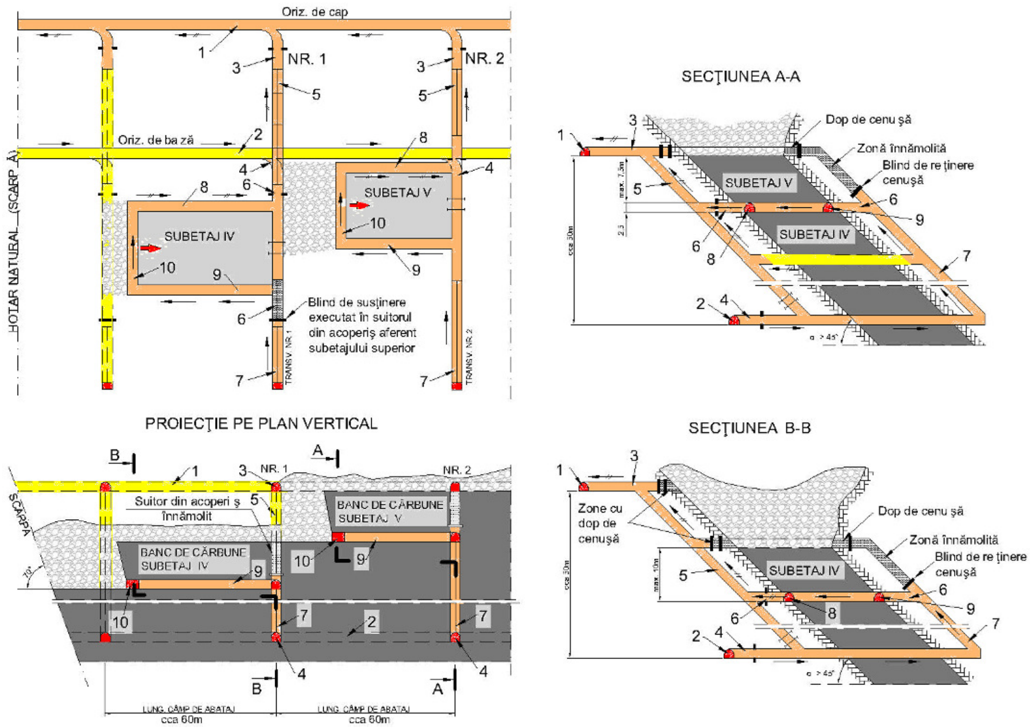

Fig.2. Top coal caving mining method in horizontal slices, with directionally longwall faces, applied at the coal seam no.3

1/2 – transport/ventilation directionally gallery; 3 / 4 -transport/ventilation cross-cut gallery; 5 – transport rise; 6-short cross-cut gallery; 7-ventilation rise; 8/9-transport/ventilation preparatory strike gallery; 10 – longwall face with top coal caving

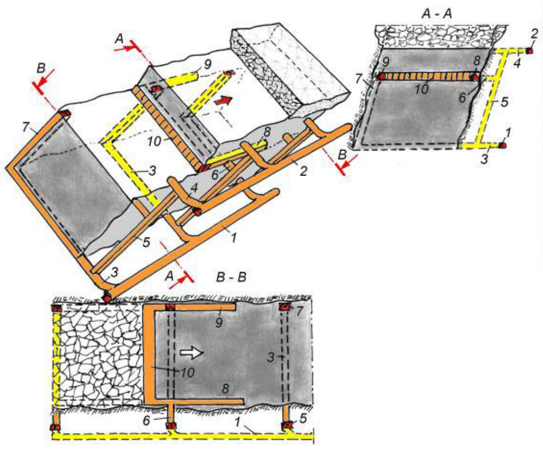

Fig.3. Top coal caving mining method in horizontal slices, with directionally longwall faces, of the thick and inclined coal seam no.3, in Petroşani coal basin [11]

1/ 2 – transport / ventilation level directionally gallery, driven in the floor rocks;
3 / 4 - transport / ventilation panel cross-cut gallery; 5 – transport shaft driven in the floor rocks; 6 – slice short cross-cut gallery; 7- ventilation shaft under the roof; 8 - slice transport preparatory working on the floor; 9 - slice ventilation preparatory working under the roof;
10 – longwall mining face with top coal caving

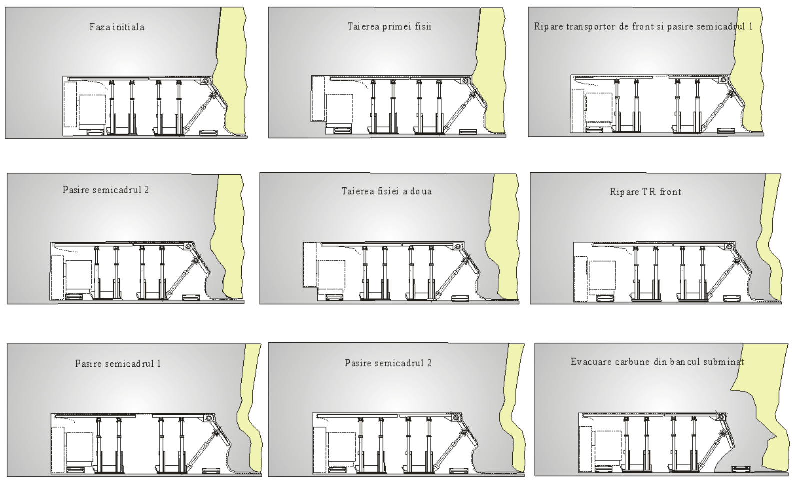

Fig.4. Frame powered support type Tau Schafer and single drum shearer FCM-120 (by courtesy of G.Chiril)

B) Mining methods and technologies for *Block II B* (strike size of 100m) and Block IIIA (strike size of 385m) are:

a) Mining method: in horizontal slices and directionally longwall coal face, with ventilation duct to the roof, under the strength ceiling, with roof rocks caving (fig.5).

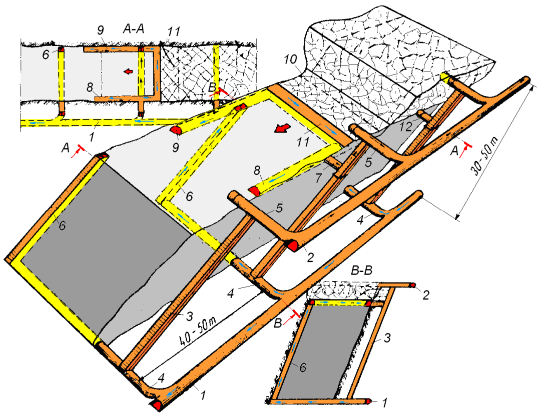

Fig.5. Mining method in horizontal slices and directionally longwall coal face

1/2 – transport/ventilation level directionally gallery; 3-panel intermediary rise; 4/5 – transport/ventilation cross-cut panel intermediary gallery; 6-ventilation rise under the roof; 7-short cross-cut gallery; 8-transport directionally preparatory gallery on the floor; 9-ventilation directionally preparatory gallery

b) Mining technologies surrounding rocks caving:

1. Drilling - blasting coal cutting, individual metallic supports (hydraulic props of 3.15m of height and articulated caps of 1.25m length) and coal transport with TR-3 armoured conveyor (see fig.3);

2. Mechanized coal cutting with the single drum shearer (ESA-60L, BESA-60L or FCM-120), individual metallic supports (hydraulic props of 3.15m of height and articulated caps of 1.25m length) and the armoured conveyor for the shearer.

1.2.2.2. Variant 2

Mining methods and technologies of the *Block II A* (strike size of 140m), *Block II B* (strike size of 100m), *Block IIIA* (strike size of 385m) and of the *Block III B* (strike size of 178m), are the following:

a) Mining method: with top coal caving in horizontal slices (slice height of 7.5m; coal face height of 2.5m and top coal height of 5m) and directionally coal face (see fig.2);

b) Top coal caving mining technologies:

1. Drilling - blasting coal cutting, individual metallic supports (hydraulic props of 2.5m of height and top coal caving articulated caps of 1.25m length, with spacers) and coal transport with TR-3 armoured conveyor (see fig.3);

2. Drilling - blasting coal cutting, frame powered supports (GEROM or Kopex type) and a single TR-3 armoured conveyor;

3. Mechanized coal cutting with the single drum shearer (ESA-60L, BESA-60L or FCM-120), frame powered supports (Tau Schafer type) and two armoured conveyors (one at the coal front – for shearer and another one, at the top coal - type TR-3) – see fig.4.

2. SCENARIOS AND VARIANTS ANALYSIS OF THE MINING METHODS AND TECHNOLOGIES

The aim of the study was to establish the necessary investments to increase the production capacity of the Lonea mine, in terms of improving financial and economic efficiency indicators of the Lonea mine as economic unity [3], [4].

Basic technical scenarios, possible to apply in the following stages of the Lonea mine development, are presented below. Finally, as a consequence of a preliminary analysis, it proposed a scenario considered most advantageous in terms of technical and economic, personnel and coal deposit safety [10].

2.1. Selection of the coal seam no.3 and 5 general mining

α) Mining stopping of the coal seam no. 3 and, in advance, opening, preparing and mining of the coal seam no. 5

This mining scenario would be necessary because the continued mining of the coal seam no. 3, with a certain descent rate in depth, to ensure a required production capacity over 380 000tonne/year, implicitly leads to compromise of the coal seam no. 5 reserves, by its progressive undermined (as a results of descents in deep of mining level, differently in various seam areas). Because the opening and preparing workings of the coal seam no.5 are not achieved until now, an important part of the coal reserve is compromised by undermined phenomenon [6].

We note that, due to the relatively high achievement period of the opening and preparing of the coal seam no.5 reserves (over 24 months), even by simultaneously two panels mining, at a maximum production of 60 000 tonnes/year, this production is under the planned mine production. Therefore, this scenario is not feasible [10].

β) Coal seam no.3 mining and opening, preparing and simultaneously mining of the coal seam no.5

Taking into account the required mine production capacity, over 380 000tonne/year and the necessity of the coal seam no.3 mining, without compromising by undermining [6] the coal seam no.5, and by reasons given in the variant I presentation, this scenario is not applicable, from technical point of view.

γ) Coal seam no.3 mining and opening, preparing and partial simultaneously mining of the coal seam no.5

This scenario is possible by shortening the time until the mining start of the coal seam no.5 (only in the area where is less influenced to be undermined by coal seam no. 3 and waiving a portion of coal seam no. 5), through a better organization of the driving of the opening and preparing workings and digging speed increasing by using the roadheaders. Thus, by simultaneous mining of coal seams no. 3 and 5 can achieve a mine production about of 500 000 tonnes/year, using the appropriate mining methods and technologies.

δ) Coal seam no.3 mining and the coal seam no. 5 abandonment mining

This scenario is applicable only if it is proved that economic efficiency of partial mining of coal seam no. 5 is very low. Very good quality of coal seam no. 5 reserves and the total volume almost of 600 000 tonnes, make this reserve to can not be abandoned. Therefore this scenario is excluded.

In *conclusion*, taking into account the economic efficiency of the coal deposit mining, the production capacity level required to be achieved, at least 380 000tonnes / year and that part of the coal seam no.5 reserve it was compromised by undermining and another part will be undermined, the most realistic scenario is proposed for mining the Lonea mine coal deposit is the scenario γ - coal seam no.3 mining and the simultaneous partial opening, preparing and mining of the coal seam no. 5 [10].

2.2. Selection of the coal seam no.5 mining method and technology

In the Lonea mine's conditions, coal seam no.5 presents an average dip about 22^o and an average thickness of 3.0m and the longwall face lengths of 45-95m. These difficult coal deposit conditions exclude the use of mechanized mining technologies in the terms of economic efficiency. Because the undermining of the coal seam 5 by the coal seam no.3 mining, in the Eastern wing of the block IV, related panels will be placed only in the block III zone. Estimated exploitable reserves of the coal seam no.5, between the levels 250m and 360m, is about 570 000 tonnes [10].

In the terms of referred coal deposit, it is proposed the directionally longwall mining, using the classical mining technology represented by individual metallic supports (hydraulic props of 3.15m height and articulated caps of 1250mm length) and drilling – blasting coal cutting.

2.3. Selection of the coal seam no.3 mining method and technology

2.3.1. Top coal caving mining

The reduction of the top coal height, from 7-7.5m (as practiced at the Lonea mine) at 4.5-5m, is necessary because the following reasons: the technical and economic analyses for optimization of the top coal height, in conditions of the horizontal slices mining, resulting the lowest cost for a top coal height about of 4-4.5m [7], [8], [9]; enhance the top coal recovery from the floor zone, in conditions of a dip about of 30-32^o, in the same time with the top coal height reduction; top coal height loss under 5m determines the coal face advancement speed increasing, and implicitly a pressure reduction developed on the coal face and preparatory workings supports and the reduction of the coal self - ignition risk in the gob area [2], [10], [11].

The small size of the panels (under 200m of the blocks II A, II B and III B – less of the block III A, having a directionally size of 385m), the reduced dip of the coal seam no.3 (under 32^o) and the long triangle shape at the face ends are not economic conditions to use the top coal faces with shearer and frame support units, because the long periods of stagnation of the coal faces generated by mounting, dismounting and transfer of the equipment and the reduced coal face speeds of advancement. From the technical and economic optimization analysis of the panel sizes results that under the 200m panel size, the coal mining costs increase significantly [7], [8], [9].

2.3.2. Horizontal slices mining with surrounding rocks caving

In the coal seam no. 3 areas, respectively the Blocks II B and IIIA, where the horizontal slices with roof rocks caving is applicable, the coal seam has a dip of about 30^o-32^o and a blocks strike extension of 100m, respectively 380m and a horizontal thickness (or coal face length) of approximately 40-60m.

Given the reduced dip of coal seam no.3, the triangles coal face ends lengths are very important, of about 5m, which requires a very difficult extraction (drilling-blasting coal cutting and individual timbered support frames), with very high labour and materials consumption. The complex operations required to be achieved by the coal face ends causing a lower production and productivity.

Important variation of the coal seam horizontal thickness determines variable lengths of the coal face, along the panel extension, which would require a regular removing and replacing operations of the powered support units, impossible to be achieved.

The only types of powered supports, which have the capacity to adapt to the coal face varying lengths, are the frames supports, because the variable distances between the support units. But because the face is under artificial ceiling, it is impossible, from technical point of view, to achieve the powered support setting between the face ceiling and the floor and the units moving toward the coal face.

Given the previous arguments, the use of powered supports in these circumstances of the coal seam no. 3 is inefficient, from both technically and economically point of view.

Up to now, the coal seam no. 3, blocks II B and III A, was achieved in the horizontal slices, with the directionally longwall faces, under the artificial ceiling, with surrounding rocks caving. The coal face mining technology is represented by drilling-blasting coal cutting and the individual metallic supports of the faces (with hydraulic props of 3.15m heights and articulated caps of 1.25m length). The deficiencies of this mining method and technology are the followings: great consumption of the drilling work; reducing of the coal front stability under the influence of blasting operation; intensive labour at the caps lifting and hydraulic props mounting operations; construction of a poor quality artificial ceiling that causes broken rocks falling dawns; reduced productions and productivities in the faces.

Most of the previous mentioned deficiencies can be reduced by introducing the artificial strength ceiling (formed by mounting of the articulated caps in the coal face floor) in the blocks II A and III B. This can be achieved by mining of a mounting slice in each block, just below the slice in operation.

3. CONTENTS OF STUDY REGARDING THE DEVELOPMENT OF THE LONEA MINE PRODUCTION CAPACITY

After a preliminary analysis of the mining possibilities of the coal seams no. 3 and 5, the study was focused in two directions: variant of Scenario 1, recommended, and the variant which the coal seam no. 3 is entire mined with top coal caving mining method (Scenario 2). Also, the study has been elaborated for the mine development on two stages: stage I, relevant for the level + 250m and stage II, corresponding to the development of the mine level+ 200m (both, in conformity with the Scenarios 1 and 2).

For the mentioned scenarios and steps, the following components were designed: opening, preparing and mining working methods and the relates technologies; production processes organization and cost calculation, for each type of opening, preparing and mining working; networks of electricity and compressed air supply networks, methane detection network, drinking water and mud filling systems; general transport and general ventilation of the mine; environmental impact assessment, etc.

According to the scenarios and steps considered, the reserves of the coal seams no.3 and 5 were calculated, per reserve category, the structural maps of exploitable seams and the maps with opening, preparing and mining schemes, on the seams, scenarios and stages were achieved (vertical longitudinal and cross sections; three-dimensional perspective representations of the topographical surface, coal deposit and workings networks). In the terms of topographical maps, calculations were made in two versions, both in the Petroşani coal basin reference system, called "Jiu Valley-58" and the "Stereo -70" (figures 6, …,10) [10].

Also, in the mentioned scenarios, the staggering in time of opening, preparing and mining workings, of the production and human resources and implicitly, the staggering of investments (mining workings and plants, machineries, equipment’s, etc.) were designed – table 1, 2 and 3 [10].

At the end of the study, in the case of two scenarios taken into study, an economic and financial analysis was achieved, which included: the estimated cost of the investment, cost - benefit, funding sources, estimates of the labour force employed by the investment and main technical and economic indicators.

Table 1. Annual staggering of the total production of the coal seams no.3 and 5 and the quality indicators – Scenario 1 [10]

Specification	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Average ash, %	42.1	41.24	40.54	41.25	40.43	40.83	40.97	40.44	41.01	40.81
Moisture, %	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Caloric content, kcal/kg	3664	3732	3788	3732	3797	3765	3754	3796	3750	3766
Daily output, tonne/day	983	1712	1625	1745	1701	1770	1822	1637	1756	1694
Total production of the coal seam no.3 and 5, tonnes	247700	431500	409550	439700	428700	446050	459150	412500	425550	426850

Table 2. Annual staggering of the total production of the coal seams no.3 and 5 and the quality indicators – Scenario 2 [10]

Specification	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Average ash, %	42.29	42.66	42.98	43.97	43.75	44.42	44.82	44.14	44.83	44.50
Moisture, %	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Caloric content, kcal/kg	3460	3460	3450	3460	3470	3440	3440	3310	3060	3340
Daily output, tonne/day	920	1411	1258	1532	1669	1857	2114	1925	2123	1986
Total production of the coal seam no.3 and 5, tonnes	231750	355650	317050	386000	420500	468050	532800	485150	534900	500550

Table 3. Synthesis of the technical and economic indicators obtained in the case of Scenario 1 and Scenario 2 [10]

Indicator	MU	Scenario 1	Scenario 2
Opening workings	m	3 459	3 459
Preparatory workings in rocks	m	4 626	4 891
Preparatory workings in coal	m	12 867	12 387
Total preparatory workings	m	17 493	17 248
Total workings	**m**	**20 952**	**20 707**
Production	10^3 tonnes	4 144.25	4 232.4
Production	Gcal	15 511 928	14 732 984
Ash	%	41.1	44.4
Caloric content	kcal/kg	3 743	3 481
Opening indicator	m/1000 tonnes	0.83	0.82
Preparing indicator	m/1000 tonnes	4.22	4.08
Opening and preparing indicator	m/1000 tonnes	5.06	4.89
Opening and preparing indicator per energetic unity	m/1000 Gcal	1.35	1.41

4. CONCLUSIONS

Following technical and economic successive analysis of scenarios presented above, the implementation of scenario 1 was recommended, due to the important advantages over the second scenario [10].

The advantages of the Scenario 1, recommended, are generated by the application in the blocks II B and III A, of the mining method in horizontal slices, with roof control by surrounding rocks caving, under the artificial strength ceiling [10].

Application of Scenario 1 will lead to lower costs of the Gcal by about 35% compared with the current situation of the Lonea mine, under a total investment of approx. $42 \cdot 10^6$ EURO [10]. However, in this situation the mine needs extra help to work with financial benefit. Therefore, it was decided that mine Lonea will enter into a staggered program of closing, until 2018.

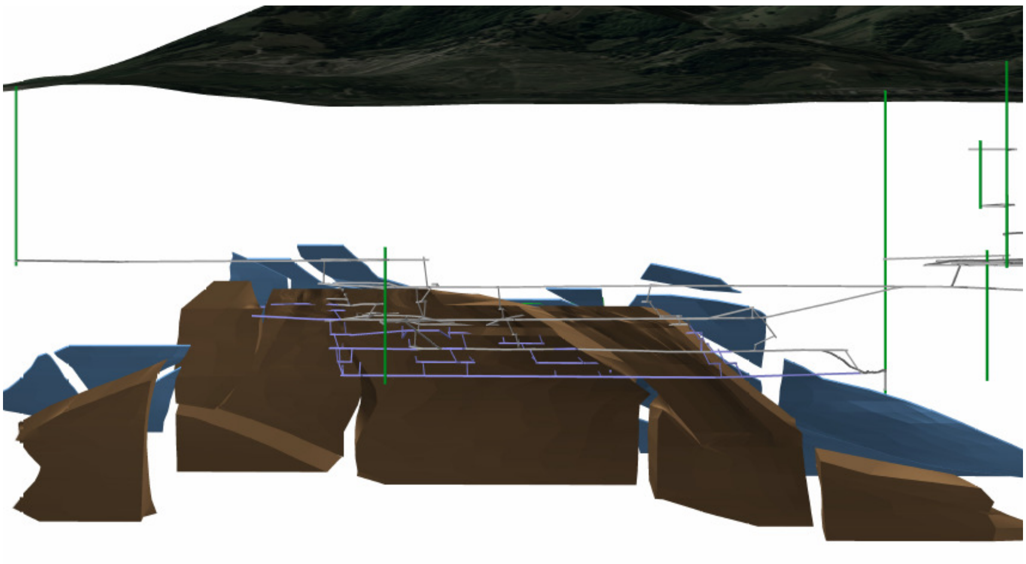

Fig. 6. 3D representation of the opening and preparing scheme of Lonea mine [10]

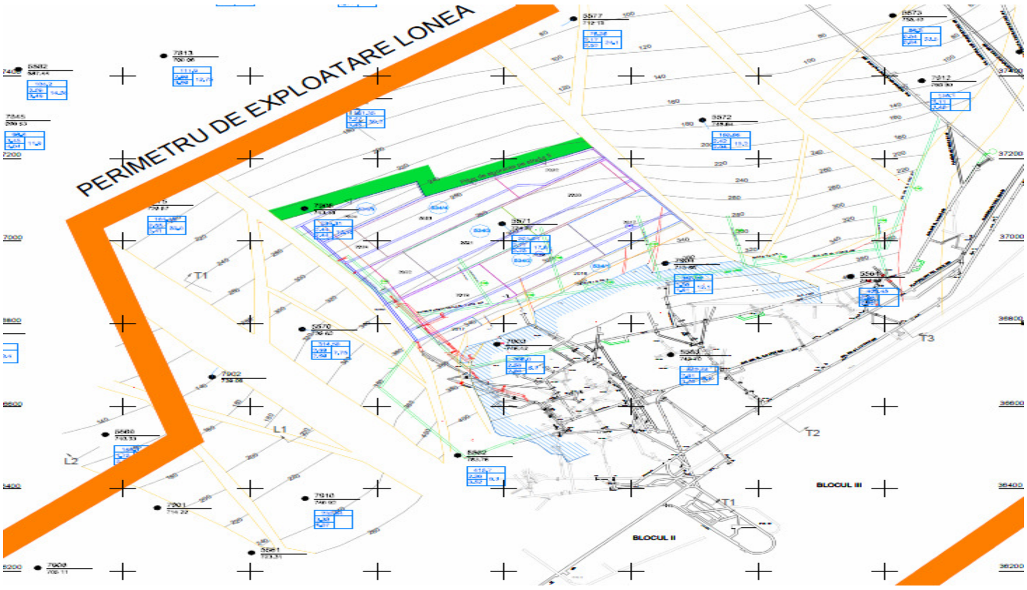

Figure 7. Opening and preparing plan of the coal seam no. 5 [10]

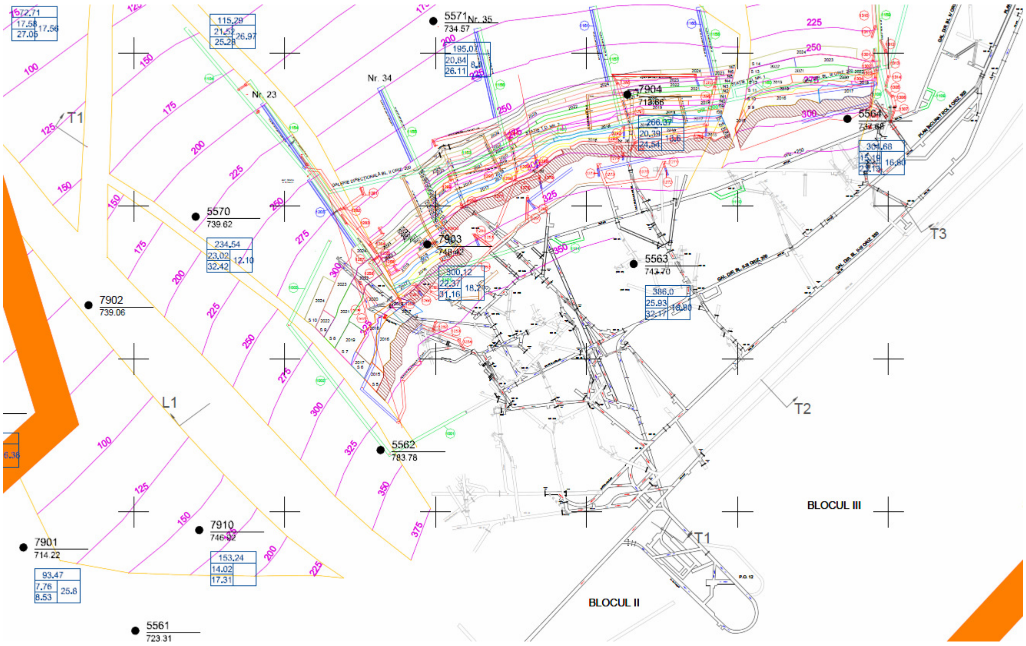

Fig.8. Opening and preparing plan of the coal seam no. 3 [10]

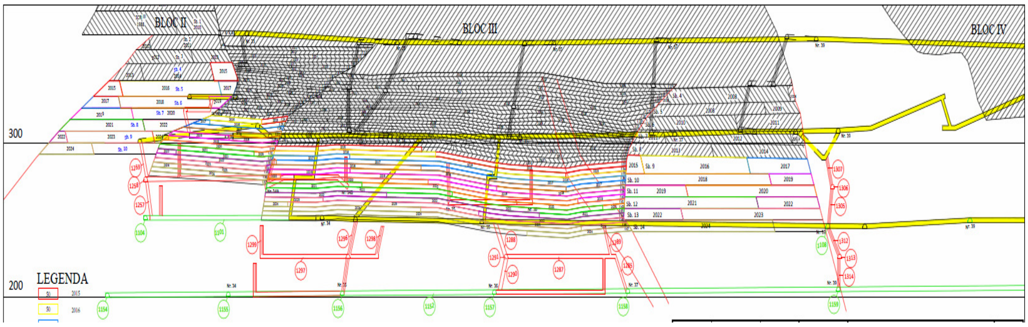

Fig. 9. Longitudinal profile of the coal seam no.3- Scenario 1 [10]

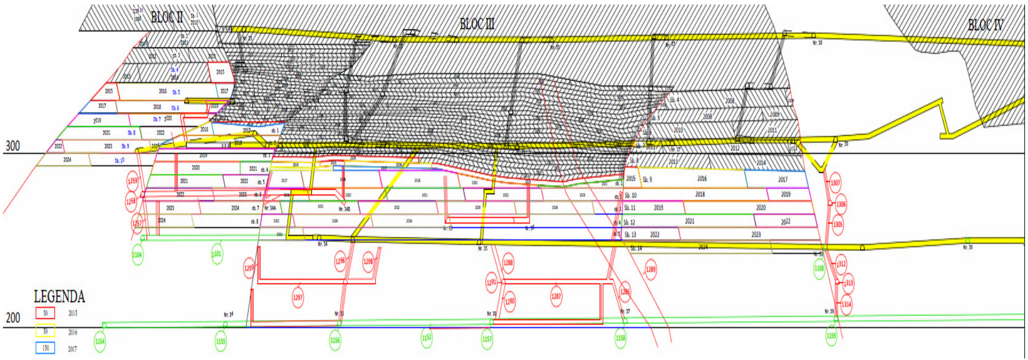

Fig.10. Longitudinal profile of the coal seam no.3- Scenario 2 [10]

REFERENCES

[1]. Covaci,Şt., *Exploatări miniere subterane*, *vol.I,* E.D.P., Bucureşti, 1983.

[2]. Badulescu,D., Onica,I., *Influence of top coal height on the performances of top coal caving mining methods in Jiu Valley coal basin*, Revista Minelor, Nr.11/2009, pag.14-16.

[3]. Mihăilescu,V., Onica, I., Cozma,E., *Parameters' Optimization of the Longwall Faces with Top Coal Caving Mining, in Horizontal Slices and Individual Support Technology***,** Annals of the University of Petroşani, Mining Engineering, Vol.13 (XXXX), 2012, pag.51-62.

[4]. Mihăilescu,V., Onica, I., Cozma,E., *Technical and Economic Optimization of the Mechanized Longwall Faces with Top Coal Caving Mining, in Horizontal Slices*, Revista Minelor Vol. 19, Nr. 2/2013, pag.31-38.

[5]. Onica,I., *Direcţii de rentabilizare a exploatării zăcămintelor din bazinul carbonifer Valea Jiului*, Revista Minelor, vol.41, nr.8, 1990.

[6]. Onica,I., *Contribuţii la perfecţionarea tehnologiilor de exploatare cu fronturi lungi de abataj a stratelor groase de cărbuni din Valea Jiului, prin utilizarea unor susţineri mecanizate adecvate condiţiilor geominiere,* Teză de doctorat, Petroşani, iunie 1995.

[7]. Onica, I., Cozma, E., Mihăilescu,V., *Technical and Economic Optimization of the Parameters of the Top Coal Caving Mining Method in the Jiu Valley Basin*, Proceeding of the 13th International Multidisciplinary Scientific Geo-Conference & EXPO - SGEM 2013 Sofia, Bulgaria, June 16-22 2013, pag. 749-756.

[8]. Onica,I., Cozma,E., Mihăilescu,V., *Improvement of the mechanized mining methods with surrounding rocks caving in horizontal slices, in the case of coal seam no.3 from the Jiu Valley coal basin*, Annals of the University of Petroşani – Mining Engineering, Vol. 14 (2013), pag.23-30.

[9]. Onica,I., Cozma.E., Mihăilescu,V., *Improvement of economic efficiency of longwall mining, in short panels, in the case of Jiu Valley thick coal seams*, Proceeding of the 11^{th} International Multidisciplinary Scientific Geo-Conference & EXPO - SGEM 2011, Sofia, Bulgaria, June 19-25 Vol.I, Section "Exploration and Mining", 2011, pag. 801-808.

[10]. Onica,I. **ş.a.,** *Studiul de fezabilitate: „Lucrări pentru dezvoltarea capacităţii de producţie la E.M. Lonea, jud.Hunedoara"- lot I (Etapa I şi Etapa II)*, Contract nr.4375/2014, Societatea Complexul Energetic Hunedoara S.A.

[11]. Onica, I., Chiril, G., *Exploatarea cu banc de cărbune subminat în abataje frontale*, Ed.AGIR, Bucureşti, 2005.

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THE USE OF PETRI NETWORKS IN MODELING THE PRODUCER-CONSUMER RELATION FOR DETERMINING THE CAPACITY OF COAL DEPOSITS FROM LIGNITE OPEN PITS

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Abstract: *The main purpose of an open pit activity is the extraction and capitalization of coal by delivering it to the customers. The coal from open pits is transported through belt conveyors from excavators and delivered through high capacity vehicles into stores following the methodology of depositing in successive layers using vehicles type KSS or ASG. The storage capacity is given by the open pit production amount and by coal grit. Considering the requirements for designing a new coal store for an open pit, the paper will study the possibility of using Petri networks for modeling the producer-consumer relation. The producer process (coal extraction technologic lines) creates coal – measured in tonnes – is buffered, while the consumer process (delivery to customers) waits until the production gets buffered, gets it and delivers it to the customers. This problem involves an object with two ways access – a buffer object. In case of the producer-consumer problem for the extraction and storage, we know that the buffer between the producer and the consumer is finite, as it there are only n locations for coal stoage. Therefore, the producer cannot always cannot operate so fast as much as he wants and he needs to wait if the consumer is slow and the buffer is full.*

Keywords: *management of mining production, coal storage capacity, process technology open pits, producer-consumer problem, Petri net, producer-consumer mode, Production management features of lignite mining pits;*

1. PRODUCTION MANAGEMENT FEATURES OF LIGNITE MINING PITS

Management involves combining mining production and use in the production of material, financial and human, in order to extract a certain amount of coal, a certain quality, deadlines and minimal cost of production. Management is based on mining production techniques, applied correctly, can prove useful to verify the efficiency of work processes of extraction, storage and delivery to consumers of coal production.

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Also, production management techniques can be used to correct errors that occurred in the production process to ensure the production rhythm. One of these techniques is the use of mathematical models based on Petri net capacity rating of coal deposits (Bărbulescu C., Bâgu C., 2002).

It involves those decisions on performance requirements and desired levels of production carried out of the system. Then it comes to the decision on the number and location of necessary equipment, technologies of extraction of coal and methods of management and control to be used. Second, ensure that the functioning of the production system to meet the performance criteria set. Here are summarized planning and production management, inventory management and quality control of coal shipped coal. To achieve the basic goal of production management - ensuring the efficiency of production, general manager, managers of manufacturing activity, heads of production lines should organize a close collaboration with the departments in charge of designing the production process (coal-mining) development process technological choice of tools and materials management, recruitment and training of production staff, to unite and to train everyone to contribute and collaborate in open pits out the production (Fodor D., Predoiu I., 2015).

2. DETERMINATION AND USE OF PRODUCTION CAPACITIES IN QUARRIES

As in any economic unit Industrial maximum use of production capacities is of particular importance, the manager must organize and track how they know, use and evaluate the production capacity and on this basis to improve the substantiation of plans and rational use of the machines in technological lines and machinery for extracting coal from the deposit. In the study using coal pits as complete production capabilities is based on knowledge and rigorous determination of the size of that capacity for technological lines machines from coal extraction and storage. Production capacity to establish relationships include some factors with decisive influence (work feature size and degree of use, reaction yield, etc.) that are specific to each pit coal.

Size production capacity of the machine is determined by machine production base and features his work and the technical manual intensive or extensive. Differentiation and rigorous determination of the sizes of these elements presents special importance since they directly reflect the level of production capacity set.

The synthesis of all calculations relating to the production capacity of equipment that is focused on the situation syntheses production capacity. It is drawn up for each link of the production process that have established production capacity, ie extraction process streams for coal deposit career and coal pits as a whole. By correlations are established in cases synthetic production capabilities can detect and size differences in capacity to the rings that control the production process, and on this basis can orient the necessary measures or the use of surplus capacity, more especially to eliminate shortfalls, the narrow places in the production process.

Demands placed before careers coal causes a considerable increase in quality function. Product quality exerts a strong influence on their living conditions. Personal safety and health are today closely related to product quality, quality is also a prerequisite for competitiveness.

3. ANALYSIS OF THE TECHNOLOGICAL PROCESS OF EXTRACTION AND STORAGE OF COAL LIGNITE QUARRIES

The ultimate goal of the work of a career lignite mining basin of Oltenia is to extract and exploit coal by shipping the beneficiaries. It continuously has to correlate production capacity by delivery capacity; deposits of coal in the pits are designed to ensure the space required for storing lignite, thus ensuring a movement of stocks that do not prevent production or supplies coal. Among the largest deposits of coal are: Lupoaia, Rosiuta, Cocoreni (have the ability to deposit more than 100 thousand tons).

All deposits of coal mining basin component of the careers of Oltenia, are of intermediate, where coal is the run time up to 30 days. In the activity at stores stock a great movement of coal or coal loading wagons previously filed and delivered forming cavities deposition filled with fresh coal extracted from the quarry. The coal extracted from quarries is transported circuits bands of excavators and deposited large capacity equipment in warehouse stacks deposition methodology in successive layers. Filing stacks coal deposit is made by car type or ASG or KSS (Fodor D., Predoiu I.*,* 2015).

Answering coal deposits are made by car type KSS have double functions: the deposition and removal. The coal is taken from these facilities by circuits lanes at points of loading and unloaded railroad type FALS. An exception is coal deposit in Western Berbeşti career where coal loading is done with excavators' classic trucks.

The storage capacity of coal production capacity depends career grain and coal. The grain is higher, the storage capacity is smaller and vice versa. In general, if the circuits are not installed conveyors crushers to reduce grain, coal has a grain size of up to 150 mm.

Analyzing the achievements of careers lignite mining basin of Oltenia, it appears that production in 2013 was 16 185 thousand tons, while deliveries amounted to 16.815 thousand tons, so the stock of coal at year-end to 155 thousand tons. Under these conditions, the average stationary coal mining in deposits was 10 days, which has contributed to weighted average qualities on the total year of 1872 kcal/kg.

4. RESEARCH ON STORING COAL

Coal deposits have some peculiarities, and after their analysis and research the following conclusions:

1) The coal to be protected against air disintegration and self-ignition. The breakdown is produced by the absorption of atmospheric oxygen by hydrocarbons contained in the coal.

2) Problems related to reduce quality coal storage mention the following: the main factors contributing to the degradation and self-ignition in the coal storage technique are: the excessive height of the stack and placing the non-compacted coal in the stack; homogenization process lignite extracted from the mining basin Oltenia, it is very difficult to achieve due to: Changes in quality of coal strata in operation; operating conditions; Technical characteristics of the machines.

3) Homogenization tape is made by superimposing layers derived from coal with calorific different, or portions of these layers that mix tape collectors in the discharge points from their driving stations. The process is applicable for the existent careers: Jilt South Jilt North Rosia Pinoasa, Lupoaia tomatoes.

4) If the Rosia de Jiu career, the weighted average production quality is scheduled for 2103 kcal/kg at year 2011.

The necessity of applying a technique of mixing the conveyor belt by adjusting the output level to ensure a quality career average in the range 1800-2000 kcal/kg, lies in the fact that if a single extraction layers V and IX, storage should make separate stacks and by default would lead to refusal beneficiaries to purchase coal with a high ash content.

5) Coal deposits of coal homogenization is settling destination stacks, namely: stacks that will preserve for a period of time, usually forms during warm and dry weather only when you cannot deliver coal to power plants, due to objective reasons; stacks of continuous work, for which the training methodology Chevron.

6) Self-ignition is the result of thermal balance in the amount of heat produced by a coal mass traversed by a current of air is greater than the amount of heat lost through the coal mass exchange with the environment.

7) The piles of coal deposits should be placed lengthwise to the direction of movement of the prevailing winds, oriented so that the north side of the stack to be as less exposed because humidity persists longer in the north and the danger of self-ignition is higher these places. It has been found that the nuclei of fire occurring in about 2/3 of the height of the stacks.

8) Compacting piles of coal by mechanical means (roller, bulldozer blade), coal density increases from 10% to 24% compared to the initial filing. In this way, the air is removed from the stack and there are no air circulation channels. It has been estimated in a number of careers, it was found that the bulk density of compacted coal increases from 0.845 t/ m^3 for coal freshly excavated and deposited in warehouses to 1,025 t/m^3 by mechanical compaction.

5. REQUIREMENTS REGARDING THE DESIGN OF A NEW COAL DEPOSIT FOR A CAREER

Considering environmental policy on emissions of pollutants resulting from the process of storage of coal from the Rosia de Jiu career, a decision should be taken for implementing one of the solutions proposed as follows:

- Maintaining coal deposit in the current location;
- Waiver of the landfill and taking career Pinoasa coal deposit, located on Valley Timişeni;
- Waiver of the landfill and a new landfill in the northern coal quarry, east of the embankment triage point loading coal wagons;
- Waiver of the landfill and a new landfill in the northern coal quarry for delivery by rail and taking career Pinoasa coal deposit, located on Valley Timişeni, for delivery to Rovinari thermal power.

Since after arranging the deposit of coal burning in the vicinity of the power plant Rovinari career Pinoasa will make a circuit of transporting coal from this deposit was considered applicable version of the route outside the perimeter Pinoasa that could be jointly carried out by two careers. Thus, the cost of purchasing the land (approx. 6.9 ha) and route planning will be borne 50% by each of the two mining units.

Following the evaluation of the main charges and work necessary for the implementation of each of the alternatives analyzed, and environmental legislation in force for the deposit Rosia quarry, it chose which involves giving up the landfill and a new landfill for coal in the northern area of career east of the railway embankment triage. Loading wagon may be achieved by building a new warehouse but reduced to a capacity of 90,000 t. One advantage is the embankment of the railway has a height of 11 m, located between the future warehouse and city Rovinari, which will reduce the spread of emissions. For this deposit amount of expenditure amounts to approximately 45.1 mil. lei.

6. CASE STUDY ON DEVELOPING THE SIMULATION MODEL OF A COAL DEPOSIT

6.1. Discrete event dynamic system in constructing models

It's called dynamic system discrete event dynamic system which possesses the following two properties:

• The state space is a discrete set;

• Transition mechanism is driven by states with appearance asynchronous events.

According to this definition, building a model for system discrete event requires the identification of two sets discrete (finite or countable): X - state space, E - the set of events and formulating a mathematical description of the regularities in the occurrence of events in the crowd It determines the transitioning state space X.

The events of the set E can be regarded as making a frame clock asynchronous (non-scheduled) that pilots conducting transitions in clock asynchronous X. This structure should be understood as a regular clock that pilots equivalent discrete-time dynamic systems (such descriptions entry - status - exit or entry - exit). However, as problematic behavior, are fundamental differences as asynchronous clock eliminates periodicity provided just needed time to study the dynamics of discrete systems.

6.2. The mechanism for updating state model for discrete event system

In the list of events, the events are arranged in ascending order of time points when they occur. Any event has the effect of status update. Updating the list of events is the introduction of the new events, the occurrence of which is possible or not, depending on system status. We draw attention to the fact that the events should not be understood only as external to the system, which is why updating the list depends on the current status. Thus the time evolution of a model for discrete event system can be studied following procedure steps:

Step 1. The first element of the list is removed (e_1, t_1).

Step 2. Updating the time he t_1 value.

Step 3. Updating the system state due to transition triggered by the event e_1.

Step 4. Updating the list of events.

Step 1 resumes.

6.3. Concepts used to describe a Petri net

Petri network consists of a directed graph and an initial state called the initial marking. Petri net graph is directed, weighted and bipartite, consisting of two types of nodes, called positions or locations (like) respectively representing states and atomic transitions; arcs go from one position to be a transition from either a transition to a place (Jucan T., Tiplea F. L., 1999).

As a graphic symbolization positions (locations) are represented by circles, and transitions by bars or rectangles. Also, all pre-conditions (inputs) a transition are related locations through targeted direct arcs, and a transition is in turn connected by arches targeted all its post-conditions (outputs).

Generally, the network Petri is just dynamic structure of the system. To check but fairness representation introduced the concept of network Petri marked: a location/state atomic and associates the truth of its operation, the value represented by the presence (meaning "condition satisfied" or truth value "1" state) or the absence of a black spot (mark or token) in the circle representing the location.

In modeling problems using the concepts of conditions and events, conditions and positions represent transitions represent events. A transition (event) has a number of input and output positions, which represent pre-conditions and post-conditions for that event. The presence of a token in a position to be understood as a logical "true" for the condition associated with the position (Valk R., 1998).

Petri is attached to a network, generally a matrix of inputs I and outputs a matrix A the following rule:

$I_{ik} = w(p_i, t_k)$ if the location p_i is set input pi (preconditions) transition $^{\bullet}t_k$, and 0 otherwise;

$O_{jk} = w(t_k, p_j)$ if the location p_j belongs to the outputs (post-conditions) of the transition $t_k^{\bullet}$, and 0 otherwise,where w is the evaluation function.

Petri locations in a network representing a production system can mean storage areas (buffers) or have the significance of state variables of the process. The chips flowing through the network can represent quantities of production in a production system.

Petri graph associated network system is constructed by introducing all known transitions and locations of pre-conditions and post-conditions their joined by arches.

6.4. Using Petri networks in modeling problem producer - consumer

This problem involves a common object that we have access, and this object is specified to be a buffer.

The process manufacturer (technological lines for coal mining) creates coal in tones which is available in the buffer, the consumer (customer supply) wait until the charcoal production is put in buffer, take her there and eat - supplied the beneficiary.

An alternative to this problem is the problem of multiple producers / consumers multiples, several production lines extracted and stored quantities of coal are placed in a buffer common to many consumers. In Petri network solutions to this problem we start with system chips s original location process and t chip manufacturer in the original location of the dispatch process to the consumer.

Alternatively problem producer/consumer for a finite buffer. In this version of the problem producer/consumer, it is known that buffer between producer and consumer is finite, that has only n locations for storing coal. Therefore the manufacturer cannot always produce as fast as he wishes, but must wait if the consumer is slow and full buffer. Figure 1 is a solution to this problem. Final buffer is represented by two sites: B is the amount of coal that has been extracted but not yet consumed and C is the number of free locations in the buffer, the original C is *n* chips and B none.

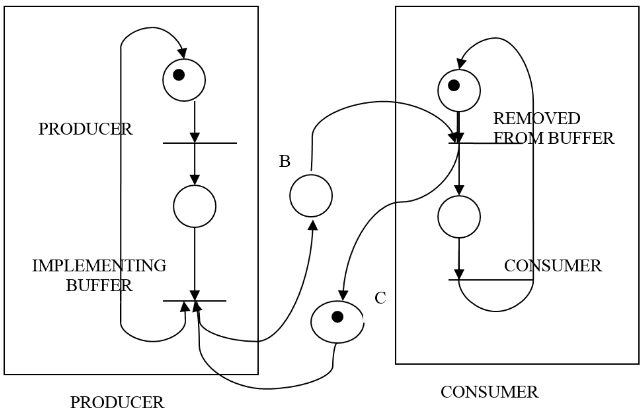

Figure 1. The problem of multiple producers / consumers multiples with finite buffer

If the buffer is full, then C will have no tokens and B will *n* chips. At this point, if the manufacturer is trying to store the extracted output buffer will be stopped because there is no chip in C to validate this transition.

6.5. Simulation model describing the operation of a coal deposit

Walk correct modeling and simulation analyze locations and network transitions Petri correspondent meanings.

The construction model home starts by identifying the status and its principal activities, followed by a description of the pre-conditions explicit conduct each event and the consequences resulting (Boldea C. R., 2006).

Figure 3 shows the operation of one producer/consumer in terms of stock coal deposit.

The set of nodes in the network is used locations: *L*={*L1, L2, L3, L4, L5, L6*}, where: *L1*: GProd – control coal production ("production ready"); *L2*: GD - storage of coal extracted command ("ready" for storage); *L3*: Stock - amount of coal in stock; *L4*: Stock′- available storage capacity meter of extracted coal; *L5*: GC - "ready" for shipping coal to the consumer; *L6*: GPrel - coal shipping demand ("ready for production").

The set of nodes used in network transitions is *T* = {*T1, T2, T3, T4*}, where: *T1*: Prod - coal production; *T2*: Dep - extracted coal storage in stock; *T3*: Prel - takeover by the consumer of coal; *T4*: Consumption - "consuming" the amount of coal shipped.

It further inputs I write matrix A and matrix outputs, which are presented in Tables 1 and 2, these tables represent the inputs and outputs of transitions to locations and vice versa. The tables are built on Figure 2.

To mark the start we have: $M_0 = (1, 0, 0, 3, 0, 1)$.

Network above us analyzed the viability, safety, repetitiveness and narrow-mindedness (behavioral and structural).

Behavioral properties network topology Petri dictated so and the initial mark of the network, and are defined as those that characterize the properties of a network model behavior over time, following a succession of transitions.

The structural properties of the non-timed Petri net are those properties which depend on the network topology and does not depend on the initial mark in one of the following meanings: whether the property is kept regardless of the original mark; whether the property is the fact that there are markings that provide some initial execution sequence of transitions.

Computer simulation and analysis in the Petri Net Toolbox allow the assessment indices (criteria) performance that characterizes the operation of coal storage process modeled by timed Petri net, expressing both customer service efficiency and use of resources (Păstrăvanu O., Matcovschi M.H., Mahulea C., 2002).

The conditions under which the experiment was conducted simulation include simulation time setting and selection of the final moment of the experiment by achieving a certain number of events, the execution of a specific transitions or chips reached a certain position. Following the simulation model with the input data set showed that storage capacity is designed at a proper technological process of lignite quarries of Rosia de Jiu.

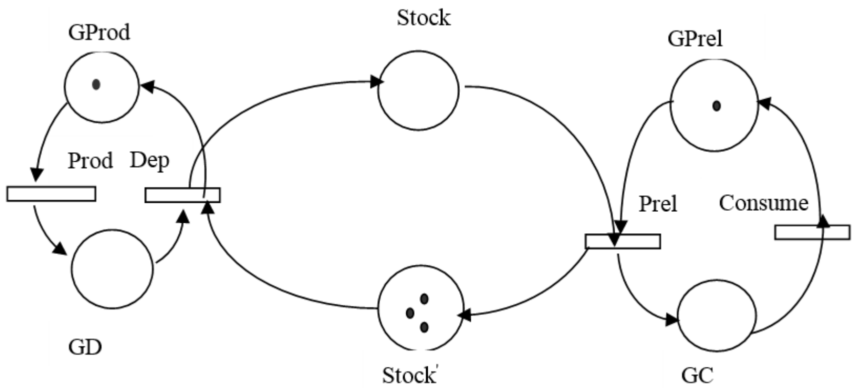

Figure 2. The producer / consumer system with a deposit of coal stock

Table 1 Inputs Matrix I^T

INPUTS	T_1	T_2	T_3	T_4
L_1	1	0	0	0
L_2	0	1	0	0
L_3	0	0	1	0
L_4	0	1	0	0
L_5	0	0	0	1
L_6	0	0	1	0

Table 2 Outputs Matrix O^T

OUPUTS	T_1	T_2	T_3	T_4
L_1	0	1	0	0
L_2	1	0	0	0
L_3	0	1	0	0
L_4	0	0	1	0
L_5	0	0	1	0
L_6	0	0	0	1

7. CONCLUSIONS

In the activity at stores stock a great movement of coal or coal loading wagons previously filed and delivered deposition forming cavities are filled with fresh coal extracted from the quarry. The storage capacity of coal in storage, production capacity depend on quarry. Modeling and simulation can contribute to understanding and improving a real system. Although the system can be very complex, it is good to try to build a model as simple as possible. This is achieved both by defining the system boundaries analyzed so as to be considered only essential characteristics in terms of objective analysis and the definition of simplifying assumptions. By modeling and simulation system of extraction, storage and delivery of lignite coal in carriers wanted was to outline the modeling power of Petri networks. This is the concrete way in which real systems can be studied as complex structure and increasing managerial performance in production processes lignite quarries.

8. REFERENCES

Boldea, C. R., *Petri Networks. Modeling and analysis*, Mirton Press, Timisoara, (2006).

Fodor, D., Predoiu, I., *Development of OLTENIA'S lignite deposits exploitation through innovation and modernization of working technology*, *Proceedings of the X edition of the Annual Conference of ASTR*, pp. 94-101, (2015).

Jucan, T., Tiplea, F. L., *Petri, theory and practice*, Romanian Academy Press, (1999).

Păstrăvanu, O., Matcovschi M.H., Mahulea C., *Applications of Petri networks in the study of discrete event systems*, Publisher Gh., Iaşi, (2002).

Valk, R., *Petri networks as token objects*: *An Introduction to elementary objects networks*, *in Proc. 19th International Conference Application and Theory of Petri Networks*, Lisbon, (1998).

Bărbulescu, C., Bâgu, C., *Production Management*, vol. I, II, Economic Tribune Publishing House, Bucharest, (2002).

Scientific Reviewer:
Assoc. Prof. PhD. Eng. Tudor GOLDAN

THE ASSIMILATION OF A NEW METAL BUILDING SUPPORT FOR THE EXECUTION OF UNDERGROUND EXCAVATIONS

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IOAN CUCU [***]

Abstract: *The concerns for a more efficient underground coal mining activity in the Jiu Valley continued on previous research results in domain of supporting for underground excavations and also in ensure stability for horizontal mine workings. Researches have been made for the introduction and assimilation of the competitive laminated profiles, for implementation of supporting and most appropriate models clamps for fastening elements. In this context, taking into account the situation encountered present in Romania with regard to the plight recorded in providing the necessary laminated profiles and clamps for implementation of metallic support for underground excavations, it is proposed and presented further in order to assimilation, a new metal building support, based on external acquisition and use of laminated profiles. similar in terms of static characteristics and resistance with the most common types designed and purchased from domestic. Besides, was studied the use of the right type of clamp for joining and tightening elements, having the shape and constructive characteristics closely related to obtaining a secure and permanent contact at the joint.*

Keywords: *underground excavation, the metal support, laminated profiles, clamps to joint, sliding elements, carrying capacity;*

1. INTRODUCTION

The sliding metal support, applied to achieve underground excavations for opening and preparation of deposits of useful minerals, involves in conventional design, combining elements (beam and two columns) with openings between the shoulders of the laminated profiles. This connection, during loading leads to damaging the of construction by compressing the upper element (beam) and split the lower

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element (pillar), with all the inconveniences arising from seizure (block) at the level of engagement with the clamps for elements sliding and hardening of support.

The new structure of support proposed for assimilation entails modifying of constructive form of the classic laminate, so be assured pressing and constant contact between elements, through hollows at the base of the collar practiced profiles.

Corresponding of the new way to combine the laminated profiles, the new support structure provides the use of appropriate clamp. The appropriate clamp has collar to level of the inferior clamp to penetrate into crevices practiced at the base of the collar profiles. It provides a controlled and uniform tightening over entire length of of the slide elements.

By replacement of current support with the new proposed structure, it overcomes the constructive drawbacks and, It is expected to increase the competitiveness and ensuring the compatibility of current and future requirements of placing and execution of excavations, due to the increase bearing capacity of metal frames supportive by approx. 30%. Also it is ensure a uniform system of sliding and much more controlled of the elements in the joints and the system will reduce current costs allocated for exploitation and maintenance.

2. LAMINATED PROFILES FOR SUPPORTING REALIZATION

In terms of ensuring internal necessary current base of profiles, In answer to encounter unfavorable situation, their purchasing from external suppliers is done via existing local companies, specialized in procurement and marketing of such product type. Among laminated profiles thus acquired externally include laminate series THN respectively THN 21, manufactured by Bulgarian STOMANA INDUSTRY SA.

That purchased laminated profile is machined under German rule DIN 21544-85, which implies execution steel 31Mn4 brand, whose composition does not provide the use of vanadium as an alloying element, and the carbon content amounts to 0.28%.

In this case the substitution of vanadium in the chemical composition or of other alloying elements for improving the structure of iron-crystalline steel execution is performed by delivering the laminate normalized condition, that is relieved from hot, in order to improve the hardness profile (frangibly), as well as a high carbon content. The letter "N" of symbols confirms the improved condition of the steel profile by applying normalization process (Pleșea et al., 2015; Vereș et al.,2015)

The firm producing a such laminate profile delivers the product in three size classes, namely THN 16.5, THN 21, THN 29, whose resistance and static characteristics (Table 1) are roughly similar to those of indigenous manufacturing laminates SG (18, 23 and 29) and constructive shape is similar with laminates from the TH class, respectively SG 29 type produced in a prior period in our country (Figure 1).

Table 1 Static and resistance characteristics of the new laminated profiles manufactured abroad

Profile type	Weight, kg/m	Section, cm^2	Moments of inertia, cm^4		Resistance modules, cm^3	
			Ix	Iy	Wx	Wy
THN 16,5	16,5	21,02	186	223	40	42
THN 21	20,92	26,65	324	398	61	64
THN 29	29,0	37,0	616	775	94	103

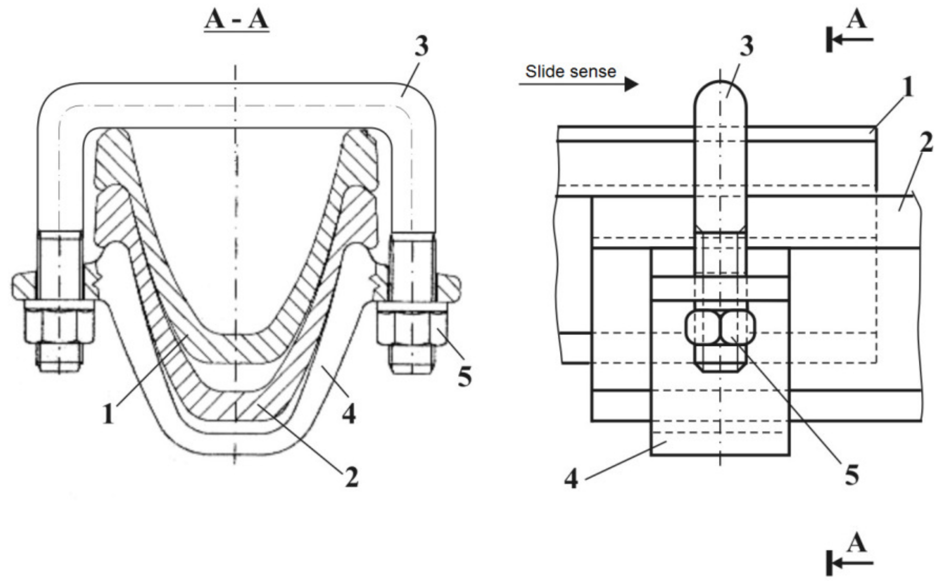

Figure 1. Metal construction supporting the new improved form: 1,2-laminated profiles, superior (beams) and lower (pillar); 3- round necklace of tightening and joining the clamp; 4- lower flat clamp; 5- the nut threaded necklace of clamp

Of the three variants of laminated possible for purchased and applied to conditions in our country, namely in underground mines in the Jiu Valley, the equivalent current domestic laminate SG 23 has proved to be the laminated profile THN 21 in point of view of its static and resistance characteristics. This is in fact the subject of the compatibility analysis performed in an earlier period for this product (Vereș et al.,2015).

Thus, based on analyzes of equivalence / compatibility performed on the two types of laminates the following assessments have been formulated:

- The shape of laminate profile THN 21 is like a trough, similar to profile SG 23, the difference being the presence of hollows practiced at the base of the laminate shoulders respectively at the collar of laminate. These grooves are designed to achieve contact at the junction profiles (joining beam supporting over the two poles) and remove the damaging of calibration which occurs when the laminate SG 23 interweaved the profiles one in another, because of higher laminate (beams) compression and splitting the lower (pillar). The shape of laminate profile THN 21 with grooves applied at the base of shoulders is similar with laminate profiles used worldwide, included in the TH series, manufactured by German DIN 21544-80 standard requirements;

- The mass of the new laminated profile THN 21 (20,92 kg/m) is reduced by about 10% compared to the mass of the laminate SG23 (23.25 kg /m) resulting in an equivalent reduction of the cross section, which is in this case 26 , 65 cm^2, compared to 30 cm^2 for the laminate SG 23. Due to the reduction of cross section and, respectively of the metal consumption by approximately 3 kg/m, the laminate THN 21 shall be reduced its size constructive too. This invokes from the beginning the use of the optimal type of clamp for joint;
- Even while reducing its dimensional characteristics, laminate THN 21 possesses strength characteristics similar in size to those of laminate SG 23, in this point of view it fits to delivery terms imposed by German standard DIN 21544-80.

Regarding the equivalence of laminate THN 21 with the other delivery requirements set by standard DIN 21544-80 (bars length, chemical composition, macroscopic state of the laminate, marking mode and baling etc.), those are required to be followed by concrete indications contained in the quality Certificate attendant from the sending of the product.

From studies of equivalence performed on the two types of laminates, the findings highlight the possibility of acquiring and using new kind of laminated profile for implementation of the metal support in underground excavations, by conditioning the ensuring of technical and quality regulations on its machining in accordance with German DIN 21544-80, restrictions which fall under the responsibility of factory.

Besides this rolled from the wide range of laminated profiles used in European countries, laminates "V" series were analyzed to see if them can be purchased and applied to underground conditions in the Jiu Valley. The characteristics of these laminated "V" series are presented in Table 2.

Table 2 Type and characteristics of rolled analyzed and proposed for implementation

No.	The laminated profile/ Country of origin	Sectional area, (cm^2)	The linear mass, (kg/m)	Static resistant characteristics			
				I_x, (cm^4)	W_x, (cm^3)	I_y, (cm^4)	W_y, (cm^3)
1.	V 21 / Poland	21,0	27,0	341	61,3	398	64
2.	V 28 / Poland	28,0	35,6	626	97	687	95
3.	V 34 / Poland	34	43,3	850	126	870,7	113,8

3. JOINING ELEMENTS OF NEW TYPES OF LAMINATES

The support has ties whose lower lugs back has shoulders obtained directly from molding in order to achieve contact with the support. Compared with conventional types of Ties used in the past, the new proposed model provides the same simple construction (Figure 1), differentiation constitutes a flat clamp fitted with shoulders. Therefore, clamping element is consisting of the round collar (3), flat clamp with shoulders (4) and screw nuts (5) (Figure 1). The round necklace has φ 28mm diameter, as in the current classic type and it is provided at the ends with thread M 27 for tightening with screw nuts. The flat clamp with shoulders has the width of 70 mm and 16 mm thick.

As with the current type of support to the overlay 400 mm of the laminated profiles, it is provided the location of two such clamps spaced 200 mm one from another and respectively at distances, of 100 mm each from the ends of the joint (Vereș et al.,2015).

The clamp can be executed with proper resources in a stamping process from OL 37 - 2k as in the current classic type and round collar can be the same as that of the composition of the current "SG 23". Assuming that the new simple type of clamp can be purchased from own sources, the it is proposed acquisition from import, with provided laminate.

Also, to reduce the cost price for ties ,it may be purchased only flat bottom clamps from imports and the round collars may be provided from own facilities existing with specific constructive adaptations.

4. DOMAIN OF USE AND IMPACTS EXPECTED

New support assembly can be applied to the execution of underground excavations having in a first phase a provisionally role, like mine galleries of various sizes located in various reservoir conditions.

In terms of execution and suitable operation, the new support structure can contribute to the following advantages (Vereș et al., 2015; Vereș et al.,2014):

- providing an elastic sliding operating mode for similar loads, but smaller in size of capacity of the support;
- increasing stability and safety in underground exploitation excavations;
- considerable reduction of consumptions of work and of additional expenses for carrying out excavations maintenance (reprofiling, hearths smoothing);
- reducing the time for panels exploitation by reducing the time allocated for maintenance, which has the consequence ensuring production rhythmicity for the main beneficiaries
- rhythmicity ensuring in implementation / purchase of rolled and clamps and continuity in exploiting of various useful minerals underground

In addition to these advantages, this type of support ensures optimal exploitation of underground excavations on much longer periods of time in terms of recovery and reuse of the supporting components, approximately in their entirety, without further intervention for any subsequent reconditioning.

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5. REFERENCES

Pleșea V., Radu S., Vereş I., Vlaicu P. Eremia M., *Competitive solutions of underground workings support aligned with the conditions of high use and performance in exploitation and use of coal for energy production,* Annals of the “Constantin Brancusi” University of Targu Jiu, Engineering Series, No.2/(2015).

Vereș I., Radu S., Ghimiși Ș., Stăncioiu A., Pleșea V., Vlaicu P., *Study and technological project regarding analyze on construction and operation of the current type of support*, Contract nr.51/01.07.2014 cu MEN –UEFISCDI Etapa a II-a in Programul Parteneriate în Domenii Prioritare — PN II, Petroșani, oct. (2015).

Vereș I., Radu S., Ghimiși Ș., Stăncioiu A., Pleșea V., Vlaicu P., *Study concerning geomechanical characterization of coal and rock lithological structures in Jiu Valley and Oltenia*. Contract nr.51/01.07.2014 cu MEN –UEFISCDI Etapa a I-a in Programul Parteneriate în Domenii Prioritare — PN II, Petroșani, nov. (2014).

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Prof. PhD. Eng. Nicolae DIMA

ANALYTIC AND COMPUTED MODELATION OF THE SPECIFIC EFFORTS FOR ELASTIC CIRCULAR MAINTENANCE WITH THREE ARTICULATIONS USED IN UNDERGROUND CONSTRUCTIONS IN CORRELATION WITH A RIGID METALLIC MAINTENANCE

CRISTINA DURA *
MARIAN CĂTĂLIN NISTOR **

Abstract: *This article shows a example about the behavior of a circular maintenance used in underground constructions. The article shows some results that was obtain in order to see what efforts appear in a metalic maintenance that it is used in a galery from Livezeni-Murga, Romania. This gallery is circular and the metallic maintenance have three articulations. We will study the efforts that appear for this kind of structure.*

Keywords: finite element method, gallery, tunnel, maintenance, corelation, articulation

1. INTRODUCTION

For o gallery from Livezeni mine we will calculate the efforts that appear in a maintenance with three articulations. The pressure from above, the rock characteristics and other datas are given bellow so based on this data we can see how does this kind of maintenance behave.

2. GENERAL DATAS NEDEED

For scaling the matalic maintenance first of all the datas about the soil proprieties, stress and pressure from above, lateral and down where gather.

The rock here have:

σ_c =450daN/cm^2 - the first type of rock

σc =336daN/cm^2 - the second type of rock

f = 3 - 5,5 and it was adapted an f =4

The appreciation of the stability distinction was made by two hypothesis:

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The M.M. Protodiakonov hypothesis in which the pressure of the rock from above is calculated:

$$P = \frac{8a^2\gamma_a}{3f} = 7{,}85[t/m]$$

The Labasse hypothesis gave the result: P= 2,6 [t/m]

The P.M. Ţimbarevici hypothesis in which the lateral pressure of the rock is calculated:

Xo= 0,075 m
Da=101,6 daN/cm^2 - active pressure
Dp= 51,3 daN/cm^2 - pasive pressure

3. SCALING THE METALIC MAINTENANCE

The circular maintenance with three articulation, witch we study, is a static determinated system.

Table 1 Main characteristics of the GDM12 profile:

Surface	Unit	Value
Practical surface	m^2	12,00
Digged surface	m^2	13,33
Total surface	m^2	13,76
Air debit	m^3/min	5760-10.800
Wather debit	m^3/hour	240
Height	m	3,412
Width	m	3,768
r (arch radius)	m	1,884

4. CALCULS OF THE EFFORTS THAT APPEAR IN A RIGID MAINTENANCE

For this static determinated system the results are given above and the scheme of the circular maintenance with three articulatins.

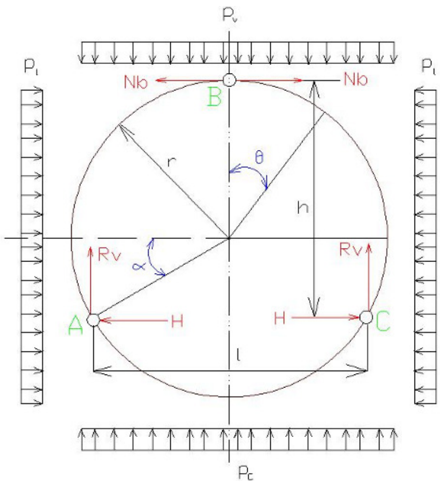


Figure 1.

The pressure generate the bellow reactions in articulations:

- in inferior articulations (A and C):

$$R_V = \frac{1}{2} p_{vl} = 3{,}925$$

$$H = \frac{-p_v r^2 \cos^2 \alpha + p_l h^2}{2h} = \frac{-7{,}85 \cdot 1{,}88^2 \cos^2 30 + 2{,}6 \cdot 3{,}412^2}{2 \cdot 3{,}412} = 1{,}391 \quad [m]$$

- in superior articulation (B)

$$N_B = \frac{p_l h^2 + p_v r^2 \cos^2 \alpha}{2h} = \frac{2{,}6 \cdot 3{,}412^2 + 11{,}068}{6{,}82} = 6{,}059 \quad \lfloor tf \rfloor$$

The moment in a arbitrary section:

$$M_\theta = N_B (1 - \cos\theta) r - \frac{1}{2} p_l r^2 (1 - \cos\theta)^2 - \frac{1}{2} p_{vl} r^2 \sin^2 \theta = -0{,}097 \quad \text{[tm]}$$

and in the section $\theta = \frac{\pi}{2}$:

$$M = \frac{p_l h^2 + p_v r^2 \cos^2 \alpha}{2h} r - \frac{r^2}{2}(p_l - p_v) = 23{,}33 \, [tm]$$

In articulations: $M_A = M_B = M_C = 0$
The longitudinal forces in any place between sections is calculated:

$$N_\theta = N_B \cos\theta + p_v r \sin^2\theta - p_l r(1-\cos\theta)\cos\theta = 2{,}18 - 0{,}324 - 1{,}63 = 0{,}208 \quad [tf]$$

and the transversal forces are :

$$Q_\theta = N_B \sin\theta - p_l r(1-\cos\theta)\sin\theta - p_l r \sin\theta\cos\theta = 5{,}63 - 1{,}726 - 0{,}318 = 3{,}586 \quad [tf]$$

above: (θ=0) : Q=0

5. COMPUTED MODELATION OF THE RIGID METAL STRUCTURE USING FINITE ELEMENTS

For the modelation of the structure the datas about the rock pressure and maintenance elements will be introduced in the Phase 2, RockSience program, as shown in figure 2.

The program will compute the manifestation of the pressure in corelation with the metal structure in steps of excavating progress. The number of steps we choose is 20 steps.

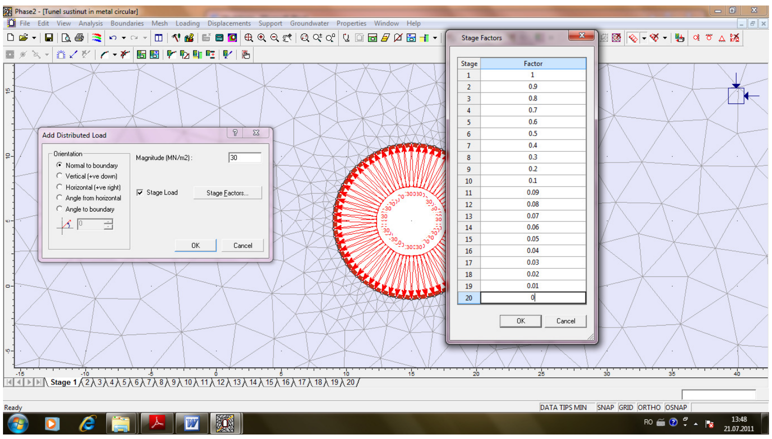
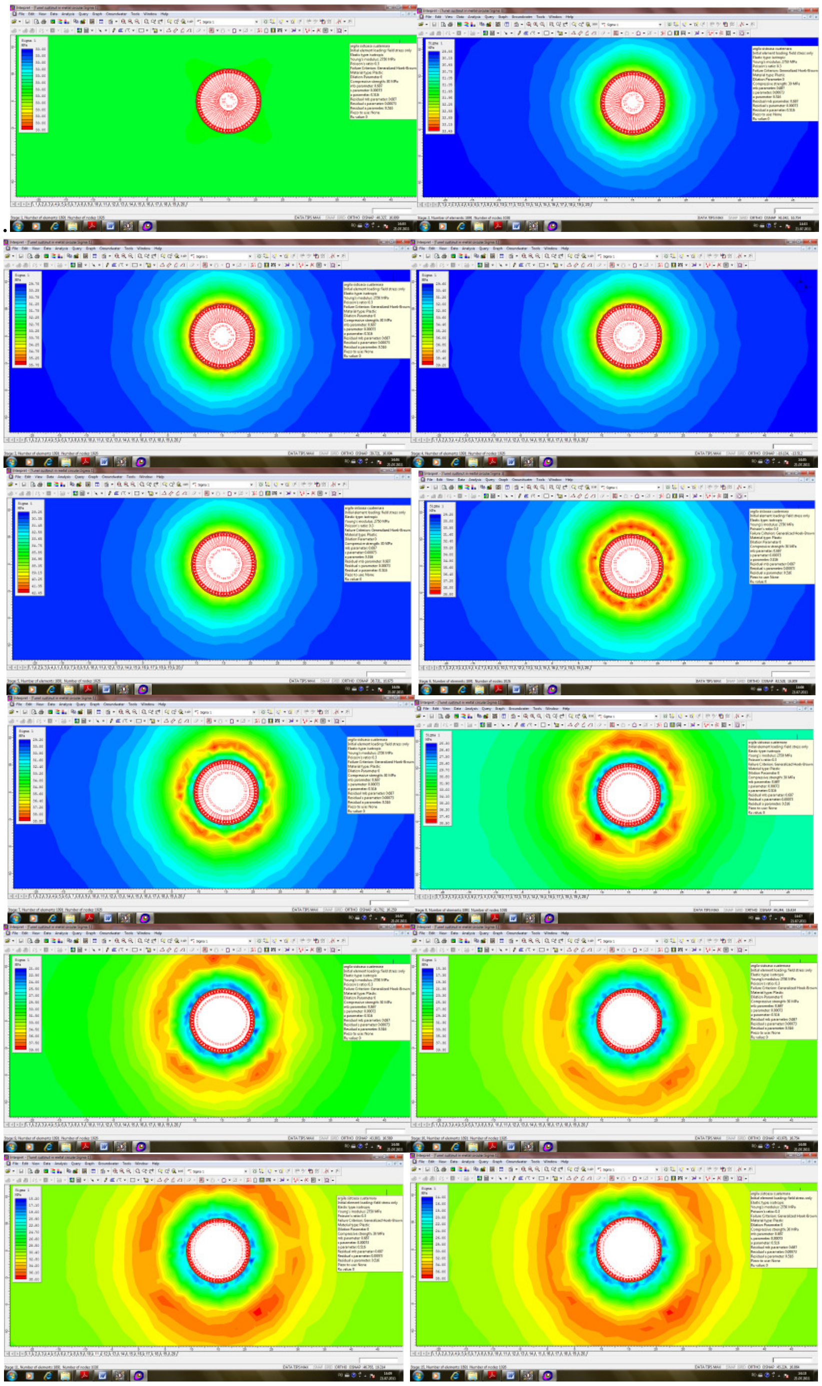


Figure 2.

For datas interpretation in figure 3 it can be observed the manifestation of the horizontal and vertical displacement and the manifestation of the tenssion σ_1, σ_3 *și* σ_z



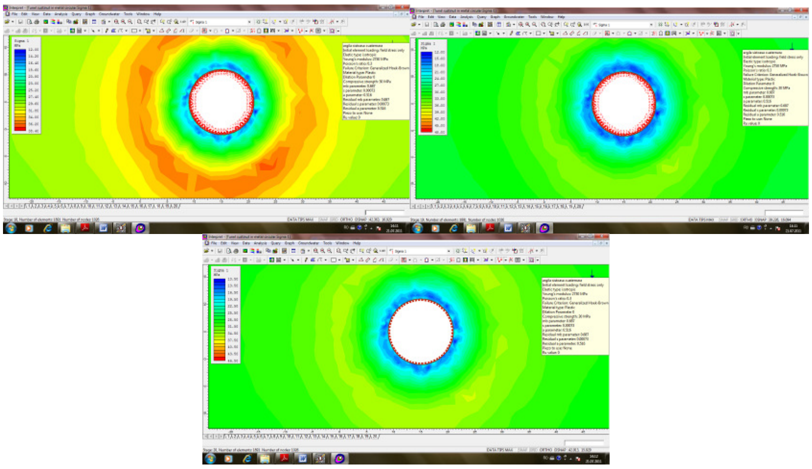


Figure 3. Manifestation of the tenssions in 1-11, 15, 18, 19, 20 state of excavation

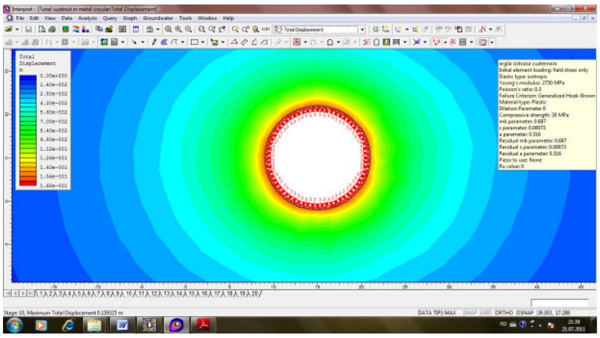
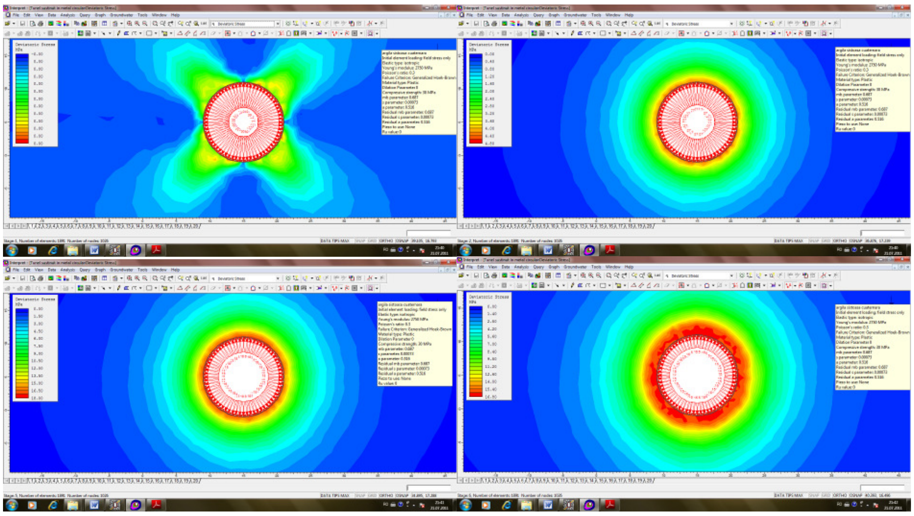


Figure 4. The horizontal and vertical displacement



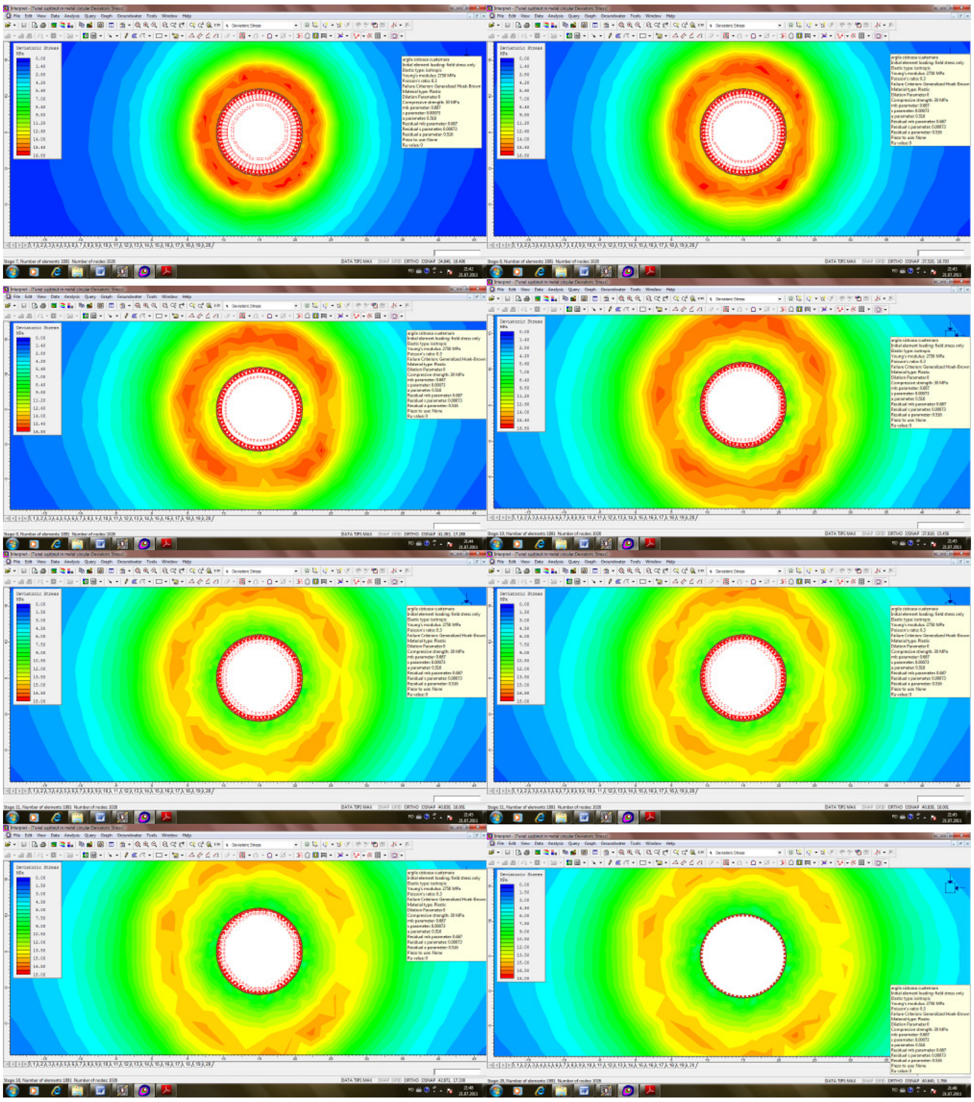


Figure 5. Repartization of the σ_1, σ_3 și σ_z tenssion in 1,2,5,6,7,8,9,10,11,15,18,20 state of excavation

It can be noticed that the displacement of the rock around the gallery is uniform so it can be concluded that the tenssion olso manifest in a unifom way. The displacement that appear in the metal structure without articulation is shown in figure 6.

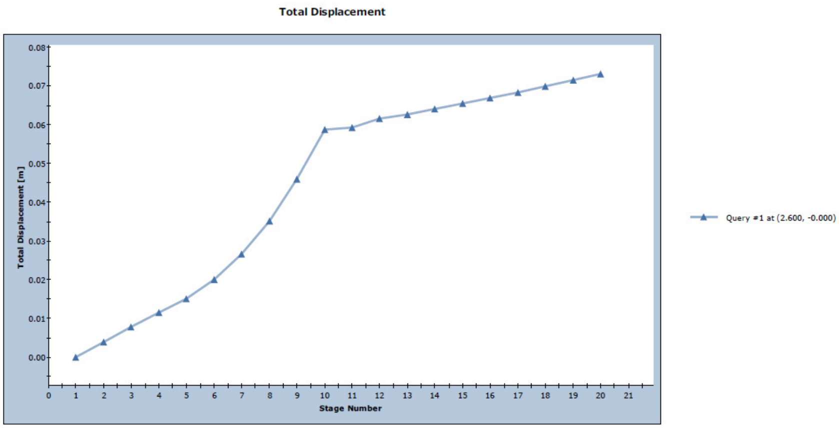


Figure 6. The displacement that appear in the rigid metal structure during the excavation steps

6. COMPUTED MODELATION OF THE ELASTIC METAL STRUCTURE USING FINITE ELEMENTS

For the case of the elastic metal structure that sustain the gallery, when the elasticity is given by the sliding gap mounted as articulation, the datas nedeed are introduced in the program Phase 2 as shown in figure 7.

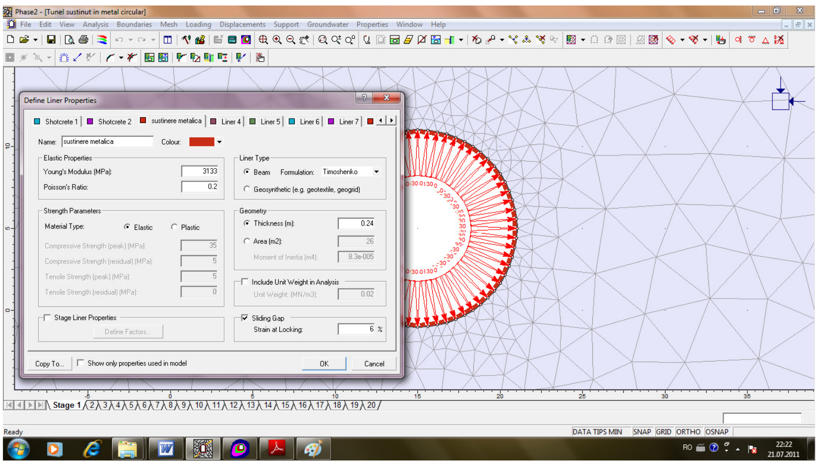


Figure 7.

Now we can make a corelation between the manifestation of the rock pressure around the rigid and elastic metallic structure in steps of excavation. In figure 8 are shown the tenssion σ_1 for the case of elastic metal structure (left) and rigid metal structure (right).

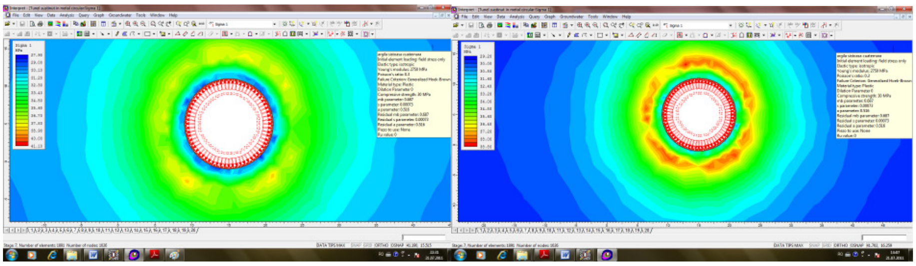


Figure 8. Manifestation of the σ_1 tenssion for the elastic structure (left) and rigid structure (right) in the 7 state of excavation

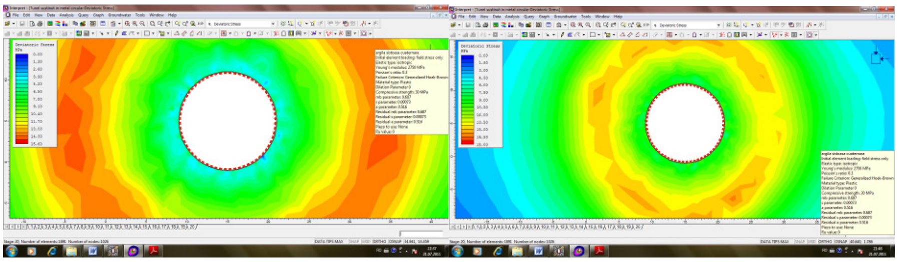


Figure 9. Repartization of the σ_1, σ_3 *și* σ_z tension for elastic structure (left) and rigid structure (right)

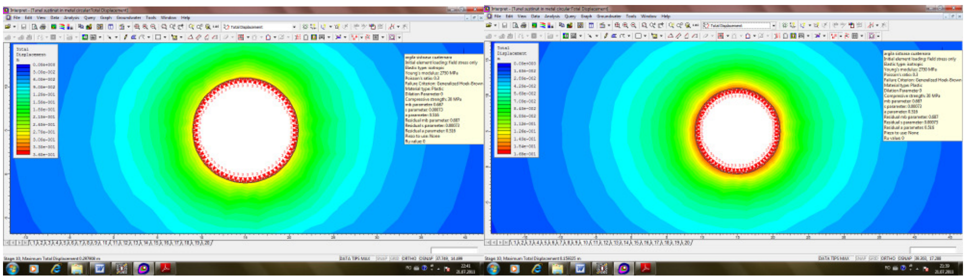


Figure 10. The vertical and horizontal displacement on the elastic structure (left) and rigid structure (right)

CONCLUSIONS

The results above shows how does the maintenance with three articulations behave under solicitations in corelation with a rigid structure that is computed for the same conditions. We must say once again that the profile GDM 12 have three articulations and for this profile the results are given above. This results that we obtain means that for the pressure that was given, for the rock characteristics and for all the factors that influence the cavity of the gallery, the three articulations resolve the problem by glideing as much as it is nedeed for the pressure to stabilize. In the case of the rigid structure the displacement have the values shown in figure 6 that indicates it's fragillity.

REFERENCES

[1] DURA CRISTINA - Studiul comportării structurilor metalice utilizate în construcțiile subterane, teză de doctorat, coordonator dr.ing. Alexandru Cătărig, Ordin ministru nr. 3818 din 26.04.2012;
[2] Popescu Alexandru : Metode de calcul al stabilitatii lucrarilor miniere subterane si dimensionarea pilierilor de siguranta, Oficiul de documentare si publicatii tehnice, Bucuresti 1973;
[3] Letu N., Carpeniseanu D. : Sustineri miniere, Editura Tehnica, Bucuresti 1973;
[4] Letu N., Radermacher L. : Metode de dimensionare a sustinerilor metalice pentru lucrarile miniere orizontale , Editura INID, Bucuresti 1995;
[5] https://www.rocscience.com/

Scientific Reviewer:
Prof. PhD. Eng. Constantin SEMEN

TECHNOLOGIES OF THE SUPPORT REBUILDING AND CONSOLIDATION OF THE CAROL SHAFT – SLĂNIC PRAHOVA SALINE

ILIE ONICA*

Abstract: *This paper refers to the degradation of the Carol shaft from Slănic Prahova Saline due to a subsidence phenomenon arisen around the shaft support and contains the synthesis of proposed technologies for support shaft rehabilitation and surrounding rocks consolidation.*

Keywords: *shaft*, *subsidence, timbered support, rebuilding technology, consolidation, rock salt*

1. ROCKS SUBSIDENCE PHENOMENON AROUND THE CAROL SHAFT

Carol shaft (Fig.1.a) was constructed between 1878 and 1881, to open the Carol mine [1] and has a depth of 231.5m, measured from the surface. Its support is made from a rectangular profile, extrados size of 3.2 x 2.4m, with two compartments to a depth of 174m, and further, of the final depth of 231.5m, it is arranged with three compartments, with 3.2 x 4.3m profile [1].

a) **b)**

Fig.1. Carol shaft - Slănic Prahova Saline [5]
a) Image taken from the surface of a Carol shaft section
b) Image with collapsed area to the level + 400m - Carol shaft

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From the + 420.7m surface level, on the depth of 6.02m, the shaft traverses the overburden rocks, mainly involved by the clays and alluvial material and the rest of 11.7m of shaft height intersects the rock salt deposit. Entire the shaft support is made by the timbering close system. Following the vertical, the shaft connects the adit at a depth of 17.84m, measured from the surface (at the level + 400m). The shaft support on the 17.84m of depth (6.02m of depth, in overburden rocks and 11.7m, in the rock salt) is made of oak elements, with a cross section of 200 x 200mm [4].

Over the years, by the rainwater infiltrations, at the contact limits between the shaft support and rock salt massive, the dissolving phenomenon of the rock salt occurred and later, the water infiltration reached the adit level. Behind the shaft support, after the rock salt dissolution phenomenon arising, the voids about of 1.21m of large were generated. The water circulation, behind the shaft support, also took a part of clay, with waterproofing role, creating a supplementary state of instability of the mining construction structure (fig.1.b).

By rocks collapse behind the timbered support, in the massive around the shaft, at the ground surface level, fractures appeared and, over the time, have expended, and at the ground surface a truncated cone is formed, with a volume of over 192m^3 and with a subsidence radius of about 5-7m (fig. 2). At the adit level, the broken rocks flowing is stopped; the worst case scenario occurs when the rocks flowing continues until the shaft volume is completely filled with caved rocks.

Pressure developed by massive rocks around the shaft, supported by the close timbered frame, calculated with Protodiakonov algorithm [2], [6] is of 0.366daN/cm^2 and after the Ţimbarevici formula [7], is of 0.367daN/cm^2. This value it was used for checking and dimensioning the shaft support elements, in accordance with the proposed technological variants.

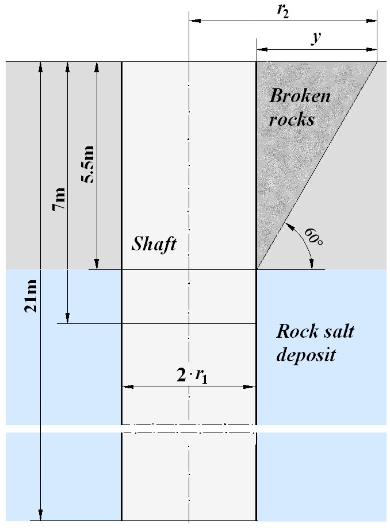


Fig.2. Subsidence area around the shaft - vertical section N-S

2. PROPOSED TECHNOLOGICAL VARIANTS FOR CAROL SHAFT REBUILDING AND CONSOLIDATION

In order to rehabilitate the Carol shaft support, from Slănic Prahova Saline, certain technological variants have been proposed [5]:

*Variant V*1 - Replacing current support with another similar oak timbering close support, with consolidation and waterproofing of rocks around the shaft support by injecting, behind the old support, a cement and flying ash mixture (fig. 3);

*Variant V*2 – Lining of the old oak support and the consolidation and waterproofing of the rocks around the shaft by injecting, behind the old support, a cement and flying ash mixture (fig. 4);

*Variant V*3 - Old timbering support is replaced with another one of concrete support (fig.5);

*Variant V*4 - Replacing current support with another similar oak support, with overburden rocks excavation in advance, the voids filling and waterproofing cover with compressed clay materials (fig. 6).

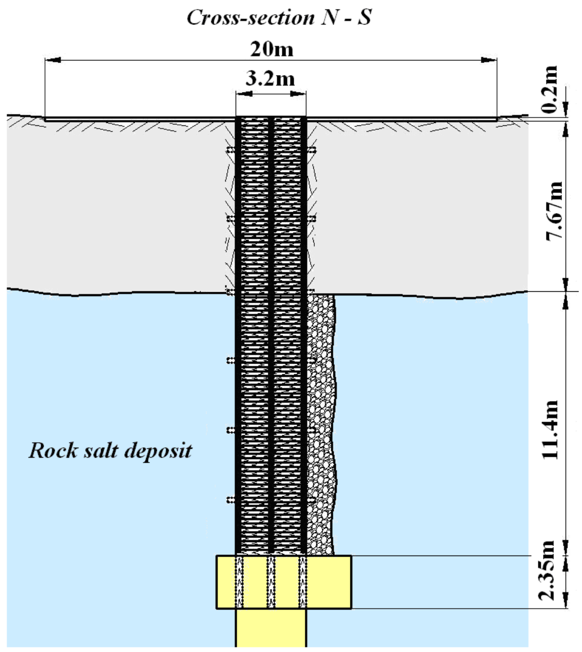


Fig.3. Rebuilding of the shaft timbering close support - variant V1

For all four proposed variants of the shaft rehabilitation, it was performed the design of: shaft supports elements; rebuilding and arrangement of shaft support, rocks waterproofing and consolidation technologies and surface construction technology; surface facilities and devices necessary for the shaft rebuilding; production planning and economic assessments of the total costs, on the calculation items [5].

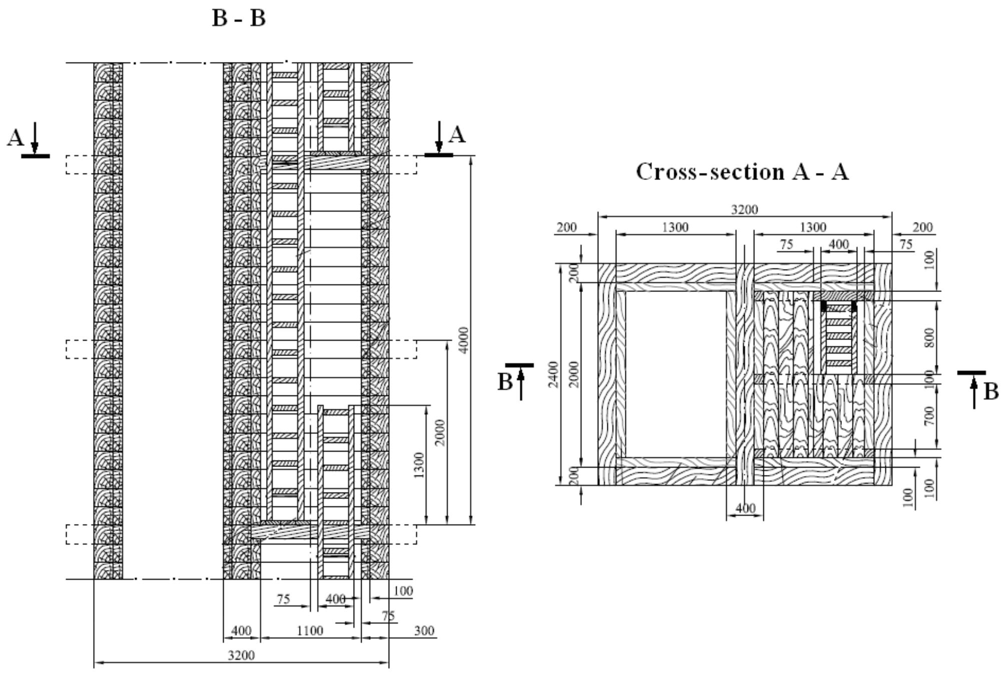
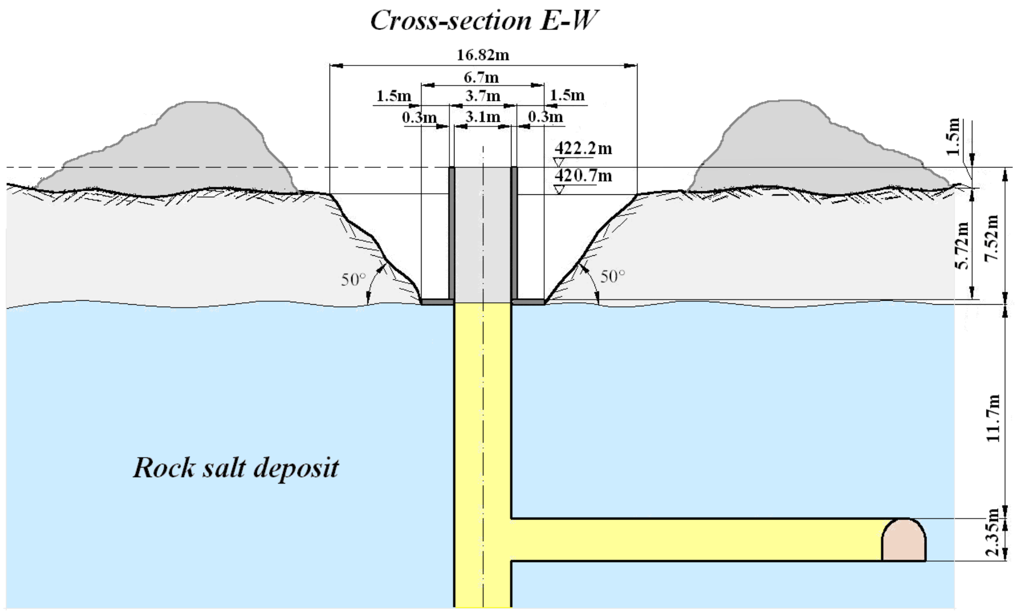


Figure 4. Lining of old oak timbering support with oak boards
of 10cm of thickness - variant V2



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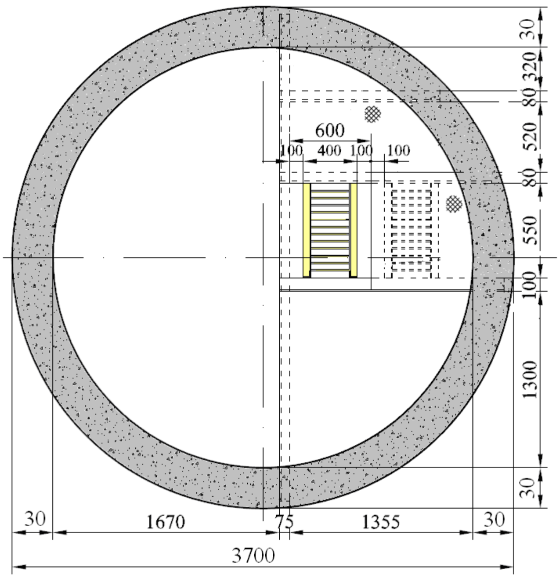
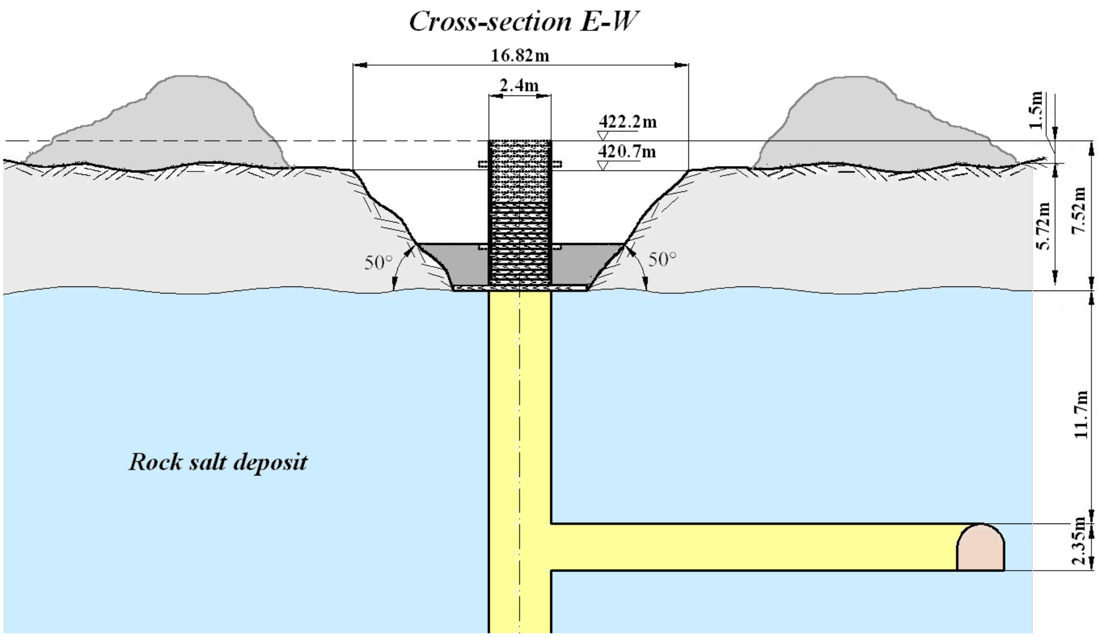


b)

Fig.5. Shaft concrete support - variant V3
a) E-W vertical section; b) Horizontal cross-section



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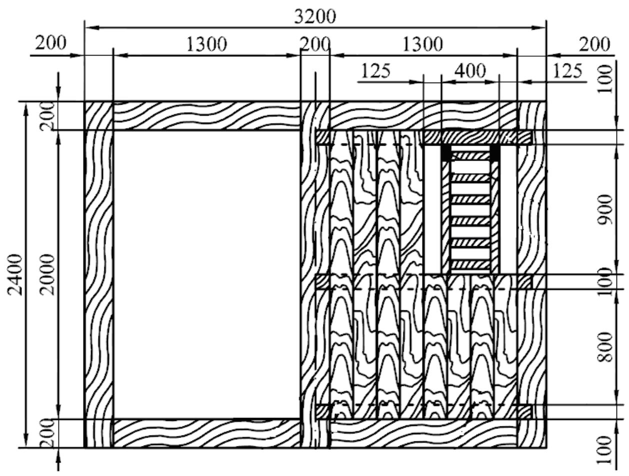

b)

Fig. 6. Rebuilding of the shaft timbering supports in the overburden rocks of deposit - variant V4
a) E-V vertical section; b) Shaft support and arrangement - horizontal section

In the case of first variant V1, the old timbered support is replaced by an identically new one, along the entire length of the shaft. At the beginning, in order to fill the voids around the shaft, following its circumference, hols are drilled between the joints of old support frames, where is injected, at 2-4 bars pressure, a mixture composed by 50% flaying ash and 50% cement M30. After mixture consolidation, behind the support, the broken rocks falling dawn is operated, collapsed at the intersection adit and Carol shaft level, and the intersection timbered support in this area is installed. Then, on the same mobile platforms, the old support elements are removed, on the sections of 2m of height, and in ascendant advancement is reconstructed the new shaft support, starting on a bearing frame. Waterproofing behind the support is achieved with compacted clay. The operation is repeated until the full support reconstruction.

The second variant V2 is the simplest, in terms of technology, because it keeps in place the old timbering support, which is lined with elements of 20 x 10cm oak boards. As in the first variant case, the process begins with the rocks consolidation operation, surrounding the shaft, by injecting the cement and flying ash sludge mixture. Upward support restoration and arrangement of the shaft, from mobile platforms, starts after sludge mixture strengthening and broken rocks collapse operation at the adit intersection, at the level +400m.

Variant V3 represents the technology of shaft support reconstruction in the concrete B200 (or B15), with a circular profile and inner diameter of 3.1m and a wall thickness of 0.3m. In this case, in a first phase, the overburden rocks are excavated to a depth of 7.52m, above the salt deposit, and it is entirely removed the old timbered close support. Then, a reinforced concrete base is constructed, with outer diameter of 6.7m, which is mounted the casing and the concrete is pumped gradually, on the sections of 2m of height. In the extrados of the support, a waterproofing protector zone of compacted clay is achieved and the remained excavation is refilled with compressed broken rocks. In the next phase, the rocks falling dawn is operated, from the level +400m, then a support leg is constructed of intersection with adit, of which recommences the upwards operation of timbered support dismantle, widening of the shaft at the circular profile and, finally, shaft concreting along the 2m of sections. The operations of shaft construction run by workers placed on a scaffold (at ground surface) and on two mobile platforms (in underground).

Variant V4, in principle, is similar to the previous one, with the difference that the shaft reconstruction is performed with timbering close frames and the geometry is identical to the original support. The first step is the overburden rocks excavation and the support dismantling, until the top of rock salt deposit and then, starting from a bearing wooden frame, a new support is reconstructed on the about 7.37m of height, in the timbered close frames. The waterproofing is done with the clay materials, placed in the supports extrados zone and then, the rest of ground surface voids are refilled with compressed broken rocks. In the next stage, the rocks falling dawn is operated at the level +400m, and starts again, from mobile platforms, the operation of old support dismantling and new support reassembling, similarly with the variant 1.

3. SELECTION OF THE OPTIMUM TECHNOLOGY OF THE SHAFT SUPPORT REBUILDING

Analysing from technical and economic point of view the previous 4 proposed variants, the following conclusions result (Onica et al., 2013):

-Variant V1, in economic terms, is close to the variant V2 (the cost being about 10% higher), having the advantage over the second one because the shaft’s oak support is entirely replaced, so increasing the timbered support sustainability; over the variant V4, which is about 20% more expensive, and the variant V1 heaving the deficiency that the voids couldn’t be fully controlled;

-Variant V2 has the advantage of being the cheapest, but the disadvantages of impossibility of the filling operation’s fully control, behind the support, and of keeping the old timbered support;

-Variant V3 is the most expensive variant of the shaft rebuilding, about of 50% more expensive in relation with the cheapest variant V2; also, it has the advantage of timbered support sustainability and integral filling of the voids with the pumped concrete;

-Variant V4 is the second option, in terms of economic efficiency and the cost shaft rebuilding, being with about 30% more expensive than the reference variant V2; in relation with the other variants with timbered support, having the advantage of support durability, which is entirely replaced, and the whole filling the voids with clay material.

4. CONCLUSIONS

For the Carol shaft rehabilitation and consolidation, affected as stability by the waters infiltration and the rock salt dissolution, four different technological variants have been proposed and designed.

As a result of comparative analysis, the variant 4 has been recommended, which aims to rebuild Carol shaft in its original form. This variant was selected, both in terms of low operation costs, of preserving the original project and, also, in terms of shaft sustainability.

REFERENCES

[1]. Hirean,C., Georgescu, M., *Stabilitatea salinelor vechi din România, condiţie a utilizării lor pentru diverse domenii – ediţia II-a*, Editura Universitas, Petroşani, 2012.
[2]. Hirian, C., *Mecanica rocilor*, Editura Didactică şi Pedagogică, Bucureşti, 1981.
[3]. Leţu, N. ş.a., *Construcţia lucrărilor miniere verticale*, Litografia I.M.P., 1986.
[4]. Onica,I., Cozma,E., Hirian,C., Georgescu,M., Marian,D. ş.a., *Proiect tehnic - Exploatarea sării cu combina la Salina Slănic Prahova,* Contract nr. 7858, din data 10.07.2012 cu SNS SA Sucursala Salina Slănic Prahova, 2012.
[5]. Onica,I., Cozma,E., Hirian,C., Georgescu,M., Marian,D. ş.a., *Refacere susţinere puţ Carol, consolidare şi impermeabilizare teren din jurul puţului, construcţie platformă betonată şi casă puţ*, Contract nr. 14512, din data 10.12.2013 cu SNS SA, Sucursala Salina Slănic Prahova, 2013.
[6]. Stamatiu, M., *Mecanica rocilor*, Editura Didactică şi Pedagogică, Bucureşti, 1962.
[7]. Ţimbarevici, P.M., *Susţinerea lucrărilor miniere*, Editura Tehnică, Bucureşti, 1953.

Scientific Reviewer:
Prof. PhD. Eng. Eugen COZMA

UNDERGROUND SUBLEVEL WORKINGS STABILITY ANALYSIS USING THE LIMIT EQUILIBRIUM THEORY

ILIE ONICA*

Abstract: *Due to the advanced cleavage rate of the ore deposit, the sublevel workings stability is low. This paper deals with the analysis of the workings' deformation mechanism and determines the model for the calculation of the strain exerted on the support, on the basis of the limit equilibrium theory, and proposes several measures for to increase the gallery stability.*

Keywords: *ore deposit, sublevel caving, gallery, limit equilibrium, stability, support*

1. INTRODUCTION

In our country, sublevel caving mining methods had a fairly wide applicability due to relatively high ore outputs and productivities. Great technical and economic performances were due to high degree of mechanization of the mining faces, represented by the drilling equipments and LHD (load, haul, dump) underground loader machines.

The application's conditions of the sublevel caving mining methods are both the ore deposit and surrounding rocks to have a good caving rate. Because the sublevel galleries are driven in the ore body deposit, their stability degree is determined by the ore deposit stability.

Location of the sublevel galleries parallel to the strike of cleavage planes does that, sometimes, the galleries' stability is impossible to be achieved, even by using the timbered close support frames.

The ore deposit has a highly schistose structure, with a low cohesion of the bedding planes, for example in the case of metamorphic or magmatic deposits genesis. Due to the loadings around the workings, to the physical -chemical alteration and the stress created by the seismic waves resulted at the blasting operations, the ore cohesion is much diminished and determines the occurrence of some slide prisms, following the cleavage's failure surfaces. The decrease of the ore strength following the failure planes extends over the whole roof height of 4m which is under the rocks fill cushion and the caved rocks. This process of ore deformation resulted in falling which propagated from the crossing area of sublevel galleries. The phenomenon occurred in time and the support was progressively damaged until they were destroyed.

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2. DEFORMATION OF THE SUBLEVEL WORKINGS

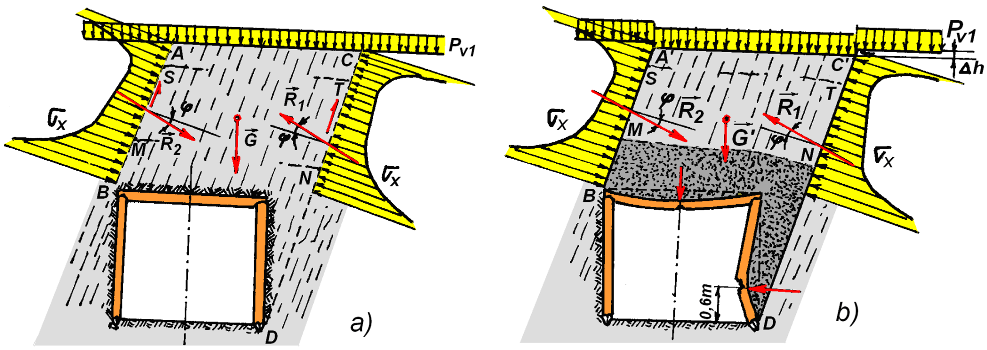
Due to the diminution of the ore strength features and the loadings on the sublevel workings supports, the ABCD slide prism occurred following AB and CD failure planes with a negligible cohesion (fig.2.a). The slide prism is maintained at the equilibrium limit by the $\vec{R}_1$ and $\vec{R}_2$ resistance forces and the $\vec{C}$ cohesion which oppose to its slide under its own weight and $\vec{P}_{v1}$ loadings exerted by the caved rocks.

In time, the ore cohesion dependent on the slide planes becomes low and the loadings value exerted on the support system exceeds the resistant forces, thus the prisms moving vertically over the Δh distance and leading to the deformation of the roof and the right wall gallery timbered support.

Because of the excessive loading of the beam and the right wall side props (at a distance about 0.6m from the floor), the support frames were completely destroyed. Due to the lateral stresses σ_x irregularly distributed (fig.2) there are produced fractures almost perpendicular to the ore stratifications following the MN and ST planes within the zones where the lateral stress reaches the maximum value. Thus, determining the caving of the BMND prism from the gallery roof over the height of 2m approximately and the complete destruction of the support system (fig.2.c) By reducing the prism weight from G to G - G' further to roof ore caving, a new equilibrium state has been reached and the AMNC prism is laterally loaded by the $\sigma_x^{'}$ redistributed stress.

If there hadn't been taken emergency measures for to support the working and void resulted further to the ore caving, the process would have continued until the complete destruction of the ore from the slide prism and the filling of the gallery with the rocks displaced from the mined out area.

The analysis of the ore falling phenomenon previously described is important for the determination of the theoretical basis of calculation method of the pressure exerted on the support and the establishment of technical measures to be taken for the improvement of the sublevel gallery stability.



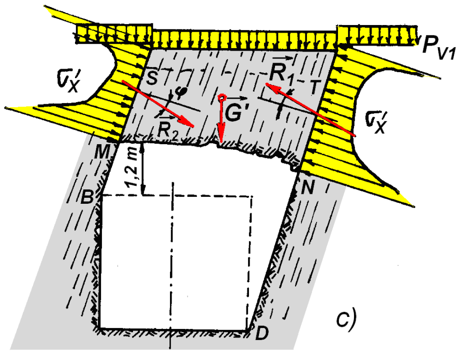


Fig.2. Ore massive deformation phenomena around the directionally sublevel galleries

3. CALCULATION OF THE PRESSURE EXERTED ON THE SUBLEVEL GALLERY SUPPORTS

For the elaboration of the model, it was assumed that the weight $\vec{G}$ of the ABCD slide prism ABCD (fig.3.a) following the AB and BC weakness planes, the slide prism taking over the additionally loading $\vec{P}_{v1}$ generated by the p_{v1} caved rocks pressure. These jointly acting on the workings roof as a vertical loading $\vec{Q}$.

The movement of these loadings is impeded by the $\vec{R}_1$ and $\vec{R}_2$ resistance forces corresponding to the AD and respectively BC slide planes with an inclination φ of frictional angle, and which tend to maintain the prism equilibrium.

The p_{v1} pressure generated by the caved rocks on the slide prism is calculated on the basis of following Mahno formula [2], [5]:

$$p_{v1} = K_2 \cdot \frac{\gamma_a \cdot a^2}{f} \text{ , [MN/m]} \quad (1)$$

where: K_2 is a coefficient depending on the size and origin of grain material; a -the half span of the sublevel working, in m; γ_a-unit weight of the caved rocks, in MN/m^3; f- coefficient representing the rock strength according to Protodiakonov [2].

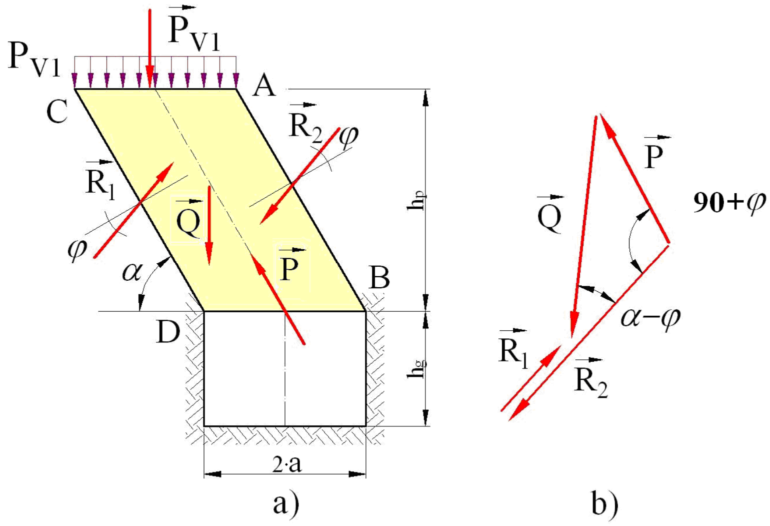


Fig. 3. Mechanism of pressure development from the roof of directionally sublevel workings

The composition of the forces acting on the slide prism (fig.3.b) will provide the calculation relationship of the $\vec{P}$ support reaction, which opposes the slide prism movement, which has an inclination angle α, by report to the horizontal:

$$P = Q \cdot \frac{\sin(\alpha - \varphi)}{\cos \varphi}, \text{ [MN/m]} \tag{2}$$

By writing the vertical component of $\vec{P}$ reaction as, the vertical pressure acting on the roof will be:

$$p_v = \frac{1}{2a} \cdot P_v, \text{ [MPa]} \tag{3}$$

Taking into account the previous relations, the final relation for the calculation of the vertical pressure exerted on the working roof is:

$$p_v = \left(\gamma \cdot h_p + K_2 \cdot \frac{\gamma_a \cdot a}{2 \cdot f} \right) \cdot \frac{\sin(\alpha - \varphi)}{\cos \varphi} \cdot \sin \alpha, \text{ [MPa]} \tag{4}$$

The pressure from the workings wall is similarly determinate according to fig.no.4 and results the following relation:

$$p_l = \left[\gamma \cdot \left(h_p + \frac{h_g}{2} \right) + K_2 \cdot \frac{\gamma_a \cdot h_g \cdot ctg\alpha}{f} \right] \cdot \frac{\cos^2 \alpha \cdot \sin(\alpha - \varphi)}{\sin \alpha \cdot \cos \varphi}, \text{ [MPa]} \quad (5)$$

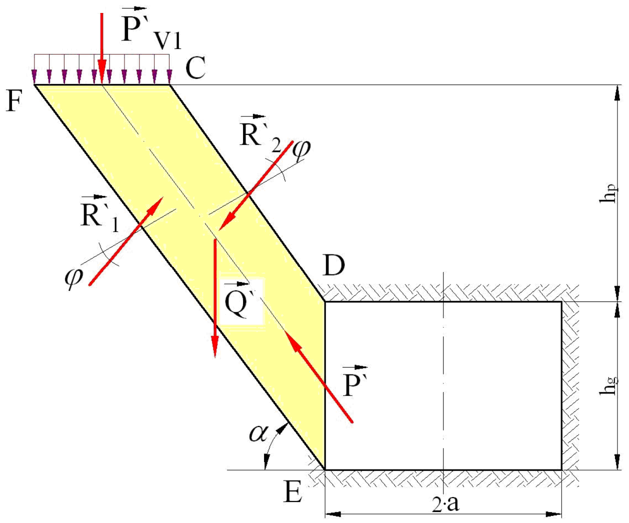


Fig. 4. Mechanism of pressure development from the directionally sublevel gallery walls

Let's assume the following average values of the parameters for the analyzed case: h_p=4m; γ=0.0283MN/m^3; $\gamma_a = 1/K_{ar} \cdot \gamma$=0.0218 MN/m^3 ($K_{ar}$ is the residual loosening factor); K_2=2.3; h_g=3.5m; a=2m; f=3.35; α=70°; φ=33°. Under these circumstances the values of the pressure exerted on the workings are: p_v=0.086MPa and p_l= 0.016MPa.

At crossing point of preparatory workings which influence extend over 9-21m, according to Peng [4], the abutment stress concentration could reach $2.5 - 4.6 \cdot \gamma_a \cdot H$; where H is the overburden strata [6]. Based on the results obtained further to analysis of the problem, it has been shown that where the gallery span reaches 6m, the pressure exerted on the support system exceed 0.3-0.4 MPa. These values show why most of the fallings started from the crossing point of the sublevel workings.

4. TECHNICAL MEASURES FOR INCREASING THE STABILITY OF SUBLEVEL GALLERIES

In order to prevent the shortcomings revealed previously, and for improving the stability of the sublevel galleries, there have been made several proposals given bellow:

-the preparatory system should be modified so that the sublevel galleries are transversal or diagonal disposed (fig. 5), thus eliminating the possibility of the slide prism detachment from the roof and implicitly, determines the improvement of these workings stability; this system allows the crossing lifetime at minimum and provides positive results regarding the workings stability;

-the crossing of the directional and transverse galleries should be at an angle of 70^{o}, which allows the access of the LHD machines, without additional widening of span galleries;

-the crossing zone should be additionally anchored and these bolts have to be disposed almost perpendicular to the splitting planes of the ore;

-at the blasting operation and particularly in the neighborhood of the crossing zones, the explosives charge should be as low as possible.

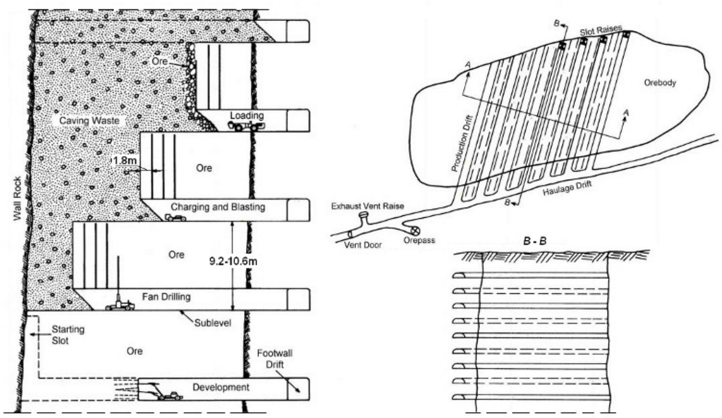


Fig.5. Diagonal disposal of the sublevel galleries,
in the case of sublevel mining method [1]

REFERENCES

[1]. Cokayne,E.W., *Sublevel Caving: An Introduction, Techniques in Underground Mining*, Selection From Underground Mining Methods Handbook, Edited by Richard E. Gertsch and Richard L.Bullock, Published by the Society for Mining, Metallurgy, and Exploration, Inc., 1998.

[2]. Hirean,C., *Mecanica rocilor*, E.D.P., Bucureşti, 1981.

[4]. Peng,S.S., *Coal Mine Ground Control*, John Wiley&Sons, New York, 1976.

[5]. Popescu,A., Todorescu,A. *Mecanica rocilor în minerit*, Ed. Tehnică, Bucureşti, 1982.

[6]. Sirokov,A.P., *Rascet ankernoi krepi dlia razlicinîh yslovii primenenia*, Nedra, Moskva, 1976.

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COAL TRANSPORTATION NETWORK IN LONEA MINE

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Abstract: Lonea Mine is over 140 years old. Energetic bituminous coal is extracted by opening mining workings specific to Jiu Valley's thick and highly inclined coal layers, such as: main and blind shafts; main level and block cross-cuts and line galleries; main ventilation raises. Bu these workings, Lonea Mine's level 400, 350 and 300 have been opened, and in the future level 250 will be opened. In layer 3, there are blocks II and III, two short undermined faces, and three to five short faces. The paper studies the flow of the coal transportation from the face tot the ground, with TR-3 rake-conveyers, TMB 1000 mining belt conveyers and extraction skips. The technical-economic analysis of these working conveyers, depending on the transportation length, the incline of the route, the power of the driving groups and the man costs established the share of the transportation cost in the cost of the extracted coal. The new flow is also presented for levels 250 and 2000, with the investments required and the economic efficiency per ton of bituminous coal.

Key words: transport flow, rake-conveyer, belt –conveyer.

1. INTRODUCTION

In the last 20 years, coal mining in the world, as well as Romanian coal mining, has experienced deep technological, economic and environment related changes. Technological processes, primarily performed by technical measures, have continuously endured restrictive actions, imposed by economic and management factors in view of rendering coal extraction process more efficient.

In the underground winning of bituminous coal in Lonea Mine, the defining elements of the increase of economic efficiency are cantered on reducing costs as much as possible. This can be achieved by a more rational management of material, human, energetic and technological resources, providing in the same time the volume required by two power units, on a more restricted market. The essential elements of technological refurbishing are complex mechanization, where it is applicable,

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production concentration and productivity increase by perfecting technologies that proved to be viable.

Exploitation of energetic bituminous coal is made by mine workings specific to development of thick, highly inclined coal layers in Jiu Valley. These are made up of main and blind shafts; main level and block cross-cuts and line galleries; main ventilation raises. By these mining workings, main levels 400, 350 and 300 in Lonea Mine have been developed and exploited, and 250 in the future. Currently, in strata 3, II and III blocks, there are two short undermined faces and three to five short faces.

Fig. 1 shows the current situation of the transportation flow of the coal from the faces to the ground with the help of TR-3 rake-conveyers(noted 1,2,3, … 12), TMB 1000 type belt conveyers(noted B_s, B_d; B_A, B_B, B_0, ...B_{35}) and winding installation with skip (PSV – shaft with the old skip). It is noticed that the coal transportation from the face to the TMB 1000 main belts is done with six or seven TR-3 cascading conveyers. This situation occurs due to development workings and to the geological-mining configuration of the coal seam [3].

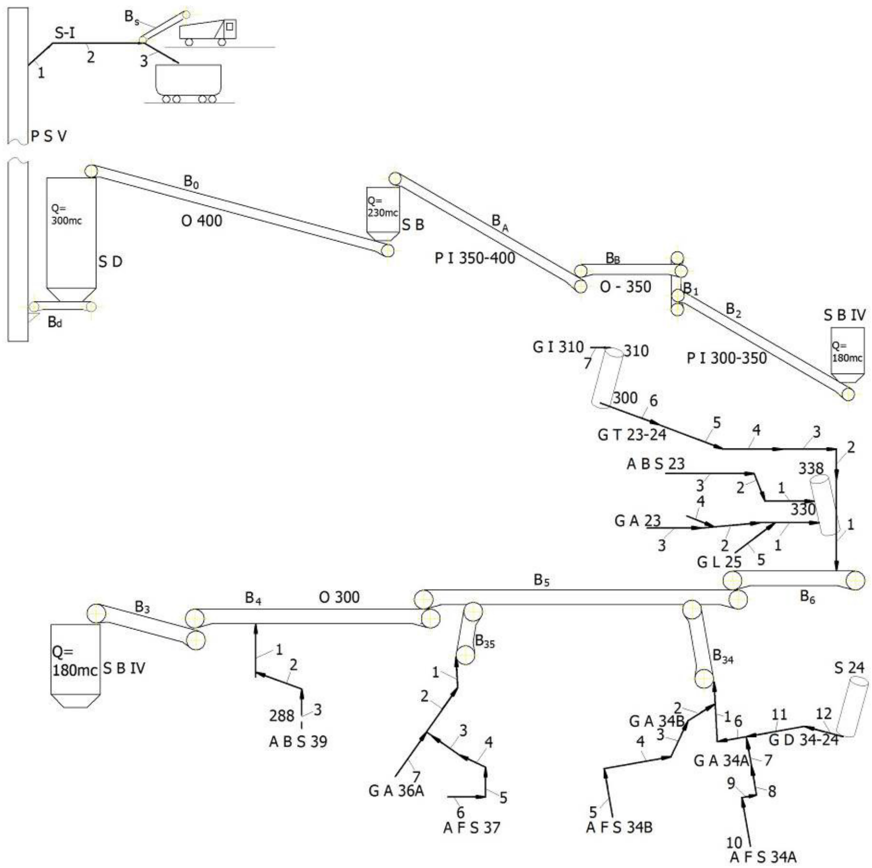

Figure 1. Coal flow from the face to the ground in Lonea Mine [3]

Where: ABS – undermined face (ABS23, ABS39); AFS – short face(AFS34A, AFS34B, AFS37); GA – attack gallery (GA23, GA34A, GA34B, GA36A); GD – line gallery (GD34-24); GI – intermediary gallery; GL – connecting gallery (GL25); GT – cross-cut (GT23-24); O – level (O 300, O 350; O 400); PI – inclined plane (PI300-350, PI350-400); S – raise (S24); S – silo (SBIV, SB, SD); S-I – sorting loading station.

In the sorting loading station a granulometric classification of 80 mm is done with the help of a sieve with rotating bars [3].

In the sorting station loading is done through an 80 mm granulomtric sieve with rotating bars. The material that goes through the sieve is deposited in surface silos, and granulation higher than 80 mm is taken over by the hand picking belt, where coal is selected manually from the rock. Coal with a granulation higher than 80 mm is deposited in surface silos and the rock is transported to Lonea I dump, with the help of TMB – 1000 belt conveyers, ot to Jiet dump by trucks.

Coal from the silos is loaded in 22 ton wagons and transported by rail to Petrila loading point, from where it is loaded in 50 ... 60 ton wagons and delivered to Mintia or Paroseni power units [3].

2. STUDY OF TRANSPORT FLOW WITH TR-3 RAKE CONVEYER.

The study of transport flow (Fig. 1) shows that the length of the TR-3 conveyers varies in the range of 10 – 80 m. There are only seven 60 m long conveyers or longer, and 17 conveyers are equipped with two driving groups each. The 36 TR-3 conveyers have 1545 m length in all, and 53x22 = 1166 kW = 1,166 MW installed power.

Due to the variableTR-3conveyer length a study of their efficiency has been made for lengths in the range of 20 – 120 m and a conveying flow volume of 0 – 105 t/h. A conveyer scheme with horizontal disruption (break) and one in vertical plane have been used (Fig. 2). The section of the conveyed coal flow is without heightener [3], [4].

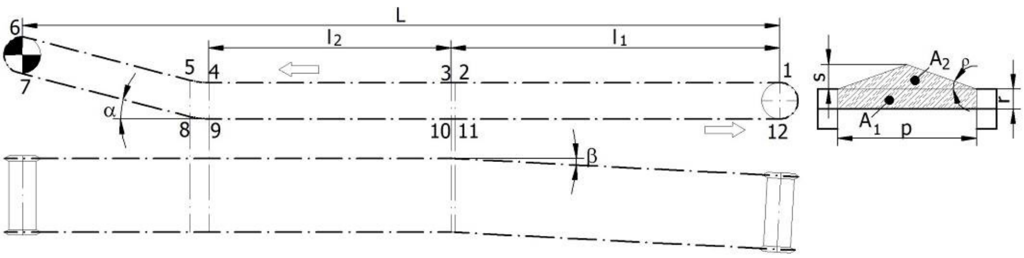

Figure 2 Scheme of TR-3 conveyer with disruption points along the chain path.

Two transportation variants have been considered for the conveyer scheme shown in Fig. 2, horizontal, variant I and ascending at 20° with a 10% horizontal part from L length, Variant II. For these variants, a MathCAD program has been drawn up to calculate the traction forces in the 12 points of the conveyer, and diagrams haven drawn for their variation along the chains, Fig. 3. For the second variant, with 20° ascending inclination, the length of the unrolled chain is higher since the same length of the horizontal projection has been taken horizontally as in the first case. The diagrams show the variation of forces for the maximum transport flow of 105 t/h (full line) and for idle run (dashed line).

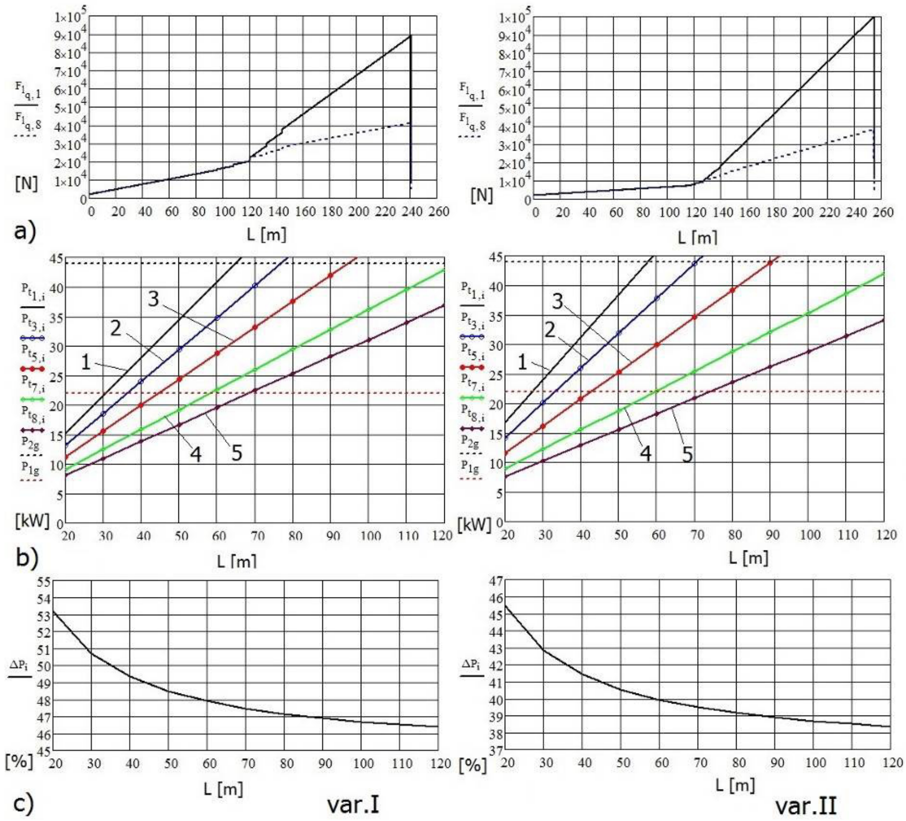

Figure 3. Diagrams of traction forces in chains, of the powers required for actuation and the percentage of power for idle run for TR-3 conveyer [3], [1]

For the two variants the power required to drive the transport has been determined and the power of the driving groups was compared for one or two 22 kW groups, Fig. 3b. These were established for various transport flows, like this: 1 –105 t/h transport flow volume; 2 - 75 t/h transport flow volume; 3 - 45 t/h transport flow volume; 4 - 15 t/h transport flow volume; 5 - d 0 t/h transport flow volume (idle run). It is noticed that the 10 t/h maximum flow can be achieved with a single group up to 30 m conveyer lengths and with two groups for up to 65 m lengths. These lengths are reduced by 3m, and 7 m, respectively, for a 20° inclination, the values are low due to the force component produced by the empty branch of the conveyer, which descends and helps in the actuation to see curve 5 for idle run. This phenomenon is also given by the power consumed for idle run, depending on the length, which varies in the range of 8,1 kW and 33,9 kW in horizontal operation, and 7,6 kW and 31,5 kW , respectively for ascending operation at 20°.

The power losses for idle run related to the power required to achieve maximum 105 t/h conveying capacity for the two cases are shown in Fig. 3c. It is seen that in all the cases the power consumed for idle run of the conveyer is more than 38%, and in the case of conveyers operating horizontally, for lengths less than 35 m, it exceeds 50 %.

3. STUDY OF TRANSPORT FLOW WITH TMB 1000 BELT CONVEYERS

TMB-1000 belt conveyers provide coal transportation at level 300 to level 400, and with the help of the 6,5 ton skip is taken to the ground and loaded in 22 ton wagons. There are two more belt conveyers for the skip to dose the coal underground, B_d ,at one for the surface for coal dosing B_s, Fig. 1. It is seen that their length varies in the range of 30 m and 468 m, only five conveyers being longer than 200 m, which are equipped four, and a belt, respectively with six 45 kW driving groups.

The 11 TMB 100 belt conveyers, the two at the skip excluded, have a total conveying length of 2283 m and 34x45 = 1530 kW = 1,53 MW installed power. If in this transport flow the winding machine at the shaft with skip is introduced, having two 500 kW motors, and the two 22 kW motor belt conveyers, 1044 kW = 1,044 MW installed power results.

Due to the variable length of the TMB 100 belt conveyers, a study has been performed for their efficiency for lengths in the range of 80 and 520 m, and a transport flow volume in the range of 0 and 455 t/h. For this a conveyer scheme has been used with two disruptions in vertical plane, the section of the coal flow conveyed is for channelling of the belt in a chute with three support rollers, with their lateral angle of 30°. Fig. 4 shows the TMB 1000 belt conveyer scheme with four driving groups, and Fig. 4b for eight driving groups.

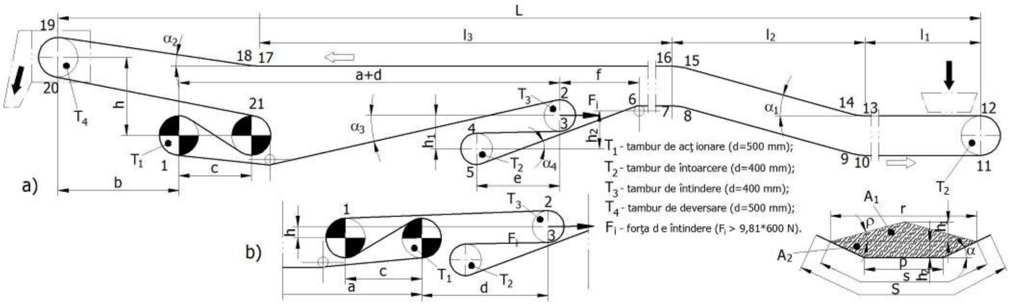

Figure 4. TMB 1000 conveyer scheme with disruption points along the belt path and four and eight driving groups [3]

For the conveyer scheme presented two conveyer variants have been taken into consideration, horizontal, variant I, and 12° ascending for a horizontal part of 10% from length L, variant II. For these variants, traction forces have been calculated in the belt for the 21 points of the conveyer and their variation diagrams have been drawn along the belt, Fig. 5a. The diagrams show the force variation for the maximum 455 t/h transport flow volume (full line) and for idle run (dashed line).

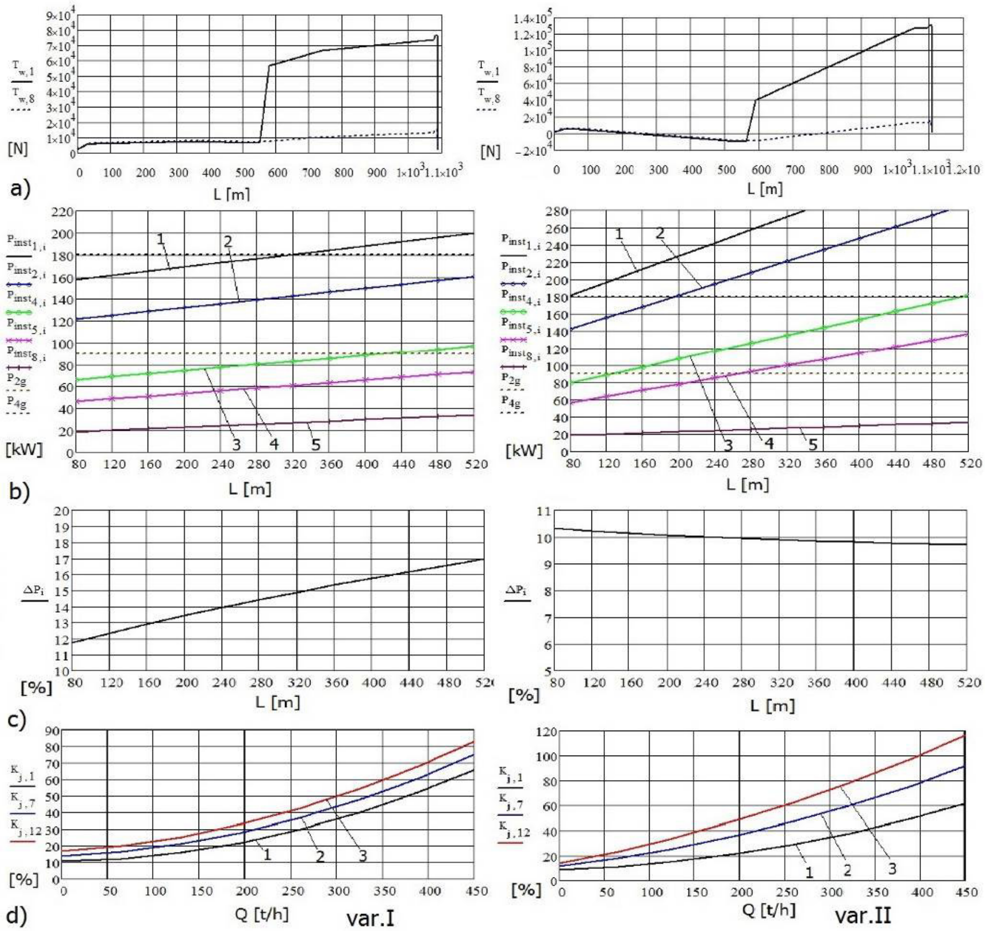

Figure 5. Variation diagrams of belt traction force, of the power required for drive, of idle run power and of degree of strain on the belt, depending on length and flow for the two variants [3]

The belt traction force diagram shows that the greatest increase occurs in the coal loading area due to differences between the belt speed and the component of the speed of coal to be loaded in the conveying direction. Similarly, the greatest influence on the driving force of the belt is played by the flow volume of the conveyed coal, being seven times greater at maximum flow compared to idle run.

The driving power required for the TMB 1000 belt conveyer for the two variants has been determined and compared to the installed driving power of two or four 45 kW groups, Fig. 5b. These have been established for various conveying flows, thus: 1 –455 t/h conveying flow ; 2 - 390 t/h conveying flow; 3 - 260 conveying flow ; 4 - 195 t/h conveying flow ; 5 - 0 t/h conveying flow (idle run). It is noticed that the 455 t/h maximum flow can only be achieved with four driving groups up to 300 m conveyer lengths and with six groups for 12°inclination and up to 300 m lengths. The power consumed for idle run function of the length varies in the range of 18,5 kW to 33,8 kW for variant I, and 18,7 kW to 33,8 kW, respectively, for variant II. This idle run power consumption, close in the two variants, horizontal and ascending at 12°, is due to the weight component on the empty ramification of the conveyer.

If the loss percentage of idle run power is related to the power required to achieve maximum 455 t/h transport capacity, variations can result presented in Fig. 5c. It is noticed that in all the cases the consumed power for idle run of the conveyer is less than 17%.

Based on traction forces a verification of the TMB 1000 conveyer belt was performed, belt with PES/PA 1000/4/1000/14insertion(1000 mm width, with 4 insertions in resistance class 4x250=1000 daN/cm and 14 mm width), resisting to a 1000 kN tear force. For a safety coefficient to static strain of 9, for normal exploitation conditions, STAS 7539-84, Table 36, a variation of belt utilization degree resulted function of the flow, Fig. 5d. This has been established for various conveyer lengths, like this:1 – 80 m long belt; 2 - 320 m long belt; 3 - 520 m long belt. It is noticed that the degree of belt utilization (strain) has values in the range of 10,6 to 83,8 % for horizontal transportation and in the range of 8,8 to117,6 % in case of ascending coal transportation at 12°, the situation of the two inclined planes being between levels 300 – 350 and 350 - 400.

4. ECONOMIC CALCULATION OF TRANSPORT FLOW

Total expenses were determined based on energy consumption, annual purchase of equipments , at least six TR-3 rake conveyers and TMB 1000 belt conveyer, spare parts and maintenance materials(grease etc.), 180 employed people at transport sector with average salary of 4629,62 lei, all expenses included. These were related to the current selling cost of ton of coal in Lonea Mine, which is P_{tc} = 3,64*113,83 = 414,34 lei/t.

The purchase price of a TR-3 conveyer is 350 000 lei, and the duration of functioning is six years, according to the Fiscal Code approved by HG 1496/2008 – the normal functioning is 4-6 years, art. 2.1.1.8, an annual payoff of A_{TR3} = 350000/6 = 58333,33 lei/year results. The purchasing price of a TMB belt conveyer is 1 500 000 lei, and the duration of functioning is 10 years, according to the Fiscal Code approved by HG 1496/2008 – the normal duration of functioning is 6-10 years, , art. 2.1.1.5, an annual payoff of A_{TMB} = 1500000/10 = 150000 lei/year resulting.

Based on these data, a list of estimate expenses has been drawn up for the present transportation flow, resulting 89,63 lei/t cost per ton of coal, which means 21,63% of the cost of the ton of coal. Fig. 6 shows the distribution of costs in the transportation flow where: 1 – expenses with salaries; 2 – expenses with equipments; 3 – expenses with energy [4].

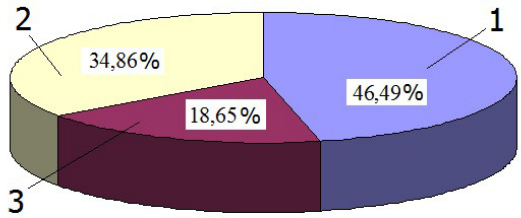

Figure 6. Distribution of expenses in the transportation flow

It is noticed that the largest share in the cost per ton of coal is expenses with salaries, due to the low degree of automation and low reliability of equipments in the transportation flow. Even if the annual energy consumption with the transport flow is 36% of the total energy consumption of Lonea Mine, this is the lowest share in the costs.

5. CONCLUSIONS

Based on the study performed, the following measures to improve bituminous coal transportation from the face to the ground are required, in Lonea Mine:

- reducing the number of TR-3 rake-conveyers in the transport flow;
- avoiding as far as possible the use of TR-3 rake-conveyers with lengths smaller than 35 m, since they have a power consumption in idle run of over 50%;
- replacing TR-3 rake conveyers with TMB 1000 belt conveyers, where the straight line transportation length is higher than 150 m and the transportation durations longer than 5 years, since the y have a power consumption in idle run of maximum 17%;
- improvement of coal loading system on the belt conveyer, by its directing in the transportation sense and reducing friction on the walls of the loading chute;
- periodic control of belt stretching forces for keeping the height next to the admitted limit of 1% of the clearance between the rollers, for maximum transportation flow;
- investments in view of automation and increase of reliability for transportation flow in Lonea.

REFERENCES

[1] Marian, I. – *Mining loading and transportation equipments*, Editura didactică şi pedagogică, Bucureşti, 1984.
[2] Ungureanu N., Ungureanu M., Mihailescu S. – *Roller belt conveyers*, Editura Risoprint, 2004, Cluj-Napoca.
[3] Cozma, B.Z., Dumitrescu, I., Urdea,Gh.B. – *Feasibility study „Workings to develop production capacity in Lonea Mine"* Symbol 40-285/R, Contract nr. APS 4375/10.11.2014, Hunedoara Power Complex.
[4] * * * - *STAS 7539-84 – Belt conveyers*, Calculation prescriptions.

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Prof. PhD. Eng. Iosif ANDRAȘ

THE WEIGHTED DISTRIBUTION AND EVALUATION OF THE ACCURACY ROUTES AND NETWORKS TOPOGRAPHIC MINING SUPPORT

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LARISA FILIP **
MARIUS CUCĂILĂ ***

Abstract: *Lifting and plotting topographical works executed to achieve the objectives mining from surface and underground support are based on a lot of points and trails stable forming polygonal networks. Mining objectives that must be designed, built and pursued their stability over time are very important from the technical, economic and social. As a result, topographic bases must meet quality requirements and correlated with the dynamic nature of mining activities.*

Keywords: *Mining surveying, topographic underground networks, errors, topographic measurements;*

1. THE PURPOSE THEME

1.Mine workings at surface and underground methods are driven by special topographical surveying relative to a base of support consists of routes or networks topographic materialized on the mining works. Therefore, it requires a proper correlation between the topographic base of support, topographic works spespeciale (stakeout) and the mining works.

2.The importance of work mine workings is characterized in that a dynamic nature, that are made in different periods. It follows that the topographic base and support must be done in stages, but results in solving corresponding network block. On the other hand methods that are required to be assessed results. Such goals will be achieved for leveling routes and networks.

3.Route geometric leveling consider points A and B between which were executed geometric precision leveling measurements (Fig. 1). If quotas are known absolute HA, HB of points A and B, leveling differences measured h1, h2, h3 are used

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to determine quotas H1 and H2 absolute two points P1 and P2 situated on the leveling AB.

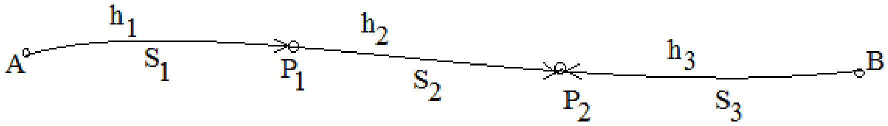

Figure 1. Route geometric leveling

Are known:

- H_A, H_B data size
- h_1, h_2, h_3 measured size
- S_1, S_2, S_3 the lengths leveling of lines between points A, P_1, P_2, B measured size

Must be determined quotas H_1 and H_2 of points P_1 and P_2 and assessed their accuracies. We denote with H_1^0, H_2^0 provisional quotas points P_1 and P_2. These are obtained as:

$$H_1^0 = H_A + h_1$$
$$H_2^0 = H_B + h_3 \qquad (1)$$

We denote with x_1 and x_2 Likely corrections and provisional quota shares they obtained probable H_1 and H_2 of points P_1 and P_2 with equality:

$$H_1 = H_1^0 + x_1$$
$$H_2 = H_2^0 + x_2 \qquad (2)$$

With the above notations can form equations:

$$(H_1^0 + x_1) - (H_A + h_1) = v_1$$
$$(H_2^0 + x_2) - (H_1^0 + x_1 + h_2) = v_2 \qquad (3)$$
$$(H_2^0 + x_2) - (H_B + h_3) = v_3$$

Or:

$$x_1 \qquad + l_1^0 = v_1; \quad l_1^0 = H_1^0 - H_A - h_1$$
$$-x_1 + x_2 + l_2^0 = v_2; \quad l_2^0 = H_2^0 - H_1^0 - h_2 \qquad (4)$$
$$x_2 + l_3^0 = v_3; \quad l_3^0 = H_2^0 - H_B - h_3$$

The system of equations obtained is solved if the condition is attached:

$$[pvv] = min \qquad (5)$$

p are measured variable weights, those weights equations errors.
Is obtained the system:

$$\begin{aligned} &(p_1 + p_2)x_1 - p_2 x_2 + p_1 l_1^0 - p_2 l_2^0 = 0 \\ &-p_2 \quad + (p_2 + p_3)x_2 + p_2 l_2^0 + p_3 l_3^0 = 0 \end{aligned} \tag{6}$$

$$\begin{aligned} &(p_1 + p_2)x_1 - p_2 x_2 + l_1 = 0; \quad l_1 = p_1 l_1^0 - p_2 l_2^0 \\ &-p_2 x_1 + (p_2 + p_3)x_2 + l_2 = 0; \quad l_2 = p_2 l_2^0 - p_3 l_3^0 \end{aligned} \tag{7}$$

The system eliminate unknown x_1 and it obtain:

$$x_1 = \frac{p_2 x_2}{p_1 + p_2} - \frac{l_1}{p_1 + p_2} \tag{8}$$

$$\left(-\frac{p_2^2}{p_1 + p_2} + p_2 + p_3\right)x_2 + \frac{p_2 l_1}{p_1 + p_2} = 0$$

$$\frac{p_1 p_2 + p_3(p_1 + p_2)}{p_1 + p_2} x_2 + L_2 = 0 \tag{9}$$

$$\left(p_3 + \frac{1}{\frac{1}{p_1} + \frac{1}{p_2}}\right)x_2 + L_2 = 0$$

$$\left(p_3 + \frac{1}{\frac{1}{p_2}}\right)x_2 + L_2 = 0 \tag{10}$$

p_2 share in the point P_2

It results the conclusion:

Leveling lines; disposed in series with weights p_1 and p_2 determine a share p_2 the relationship that exists between:

$$\frac{1}{P_2} = \frac{1}{p_1} + \frac{1}{p_2} \tag{11}$$

With these specifications we can write:

$$\begin{aligned} &(P_2 + p_3)x_2 + L_2 = 0 \\ &L_2 = l_2 + \frac{p_2 l_1}{p_1 + p_2} \end{aligned} \tag{12}$$

To note that shares generally are obtained using the lengths, so $p_i = \frac{1}{s_i}$.

Observe that the resulting correction equation x_2 is written directly by bike route leveling, as well as the initial system of equations. Will be calculated simply in the right order x_2 nd hereinafter right x_1.

For evaluation of precision must be determined: mean square error m_0 the level difference per unit length and mean square errors m_1 and m_2 they obtained probable values quota points P_1 and P_2.

Using matrix calculation we can write:

$$m_0 = \sqrt{\frac{v'pv}{n-k}} \tag{13}$$

n – number of equations

k – the number of unknowns

so:

$$n - k = 3 - 2 = 1$$

$$v'pv = l'(p - pAQ_{xx}A'p)l \tag{14}$$

In which:

$$Q_{xx} = (A'pA)^{-1} \tag{15}$$

And:

$$A = \begin{pmatrix} 1 & 0 \\ -1 & 1 \\ 0 & 1 \end{pmatrix}; \qquad l = \begin{pmatrix} l_1 \\ l_2 \\ l_3 \end{pmatrix}; \qquad p = \begin{pmatrix} p_1 & 0 & 0 \\ 0 & p_1 & 0 \\ 0 & 0 & p_1 \end{pmatrix} \tag{16}$$

It is easy to deduce that:

$$Q_{xx} = \frac{1}{D}\begin{pmatrix} p_2 + p_3 & p_2 \\ p_2 & p_1 + p_2 \end{pmatrix} \tag{17}$$

In witch:

$$D = p_1(p_2 + p_3) + p_2p_3 = p_3(p_1 + p_2) + p_1p_2 \tag{18}$$

With these:

$$Q_{xx} = \begin{pmatrix} Q_{11} & Q_{12} \\ Q_{21} & Q_{22} \end{pmatrix} \tag{19}$$

In witch:

$$Q_{11} = \frac{p_2+p_3}{D} = \frac{1}{p_1+P_2'}; \quad \frac{1}{P_2} = \frac{1}{p_2} + \frac{1}{p_3}$$

$$Q_{22} = \frac{p_1+p_2}{D} = \frac{1}{p_3+P_1'}; \quad \frac{1}{P_1} = \frac{1}{p_1} + \frac{1}{p_2} \tag{20}$$

And

$$Q_{12} = Q_{21} = \frac{p_2}{D} = \frac{1}{p_1+p_3+\frac{p_1 p_3}{p_2}} \qquad (21)$$

Finally we can write:

$$m_1 = m_0\sqrt{Q_{11}}$$
$$m_2 = m_0\sqrt{Q_{22}} \qquad (22)$$

Weighting coefficients Q_{11} and Q_{22} are obtained simply by leveling route scheme. In this way is obtained Q_{xx}.

2. CONCLUSIONS

Underground routes and geometric leveling networks are made appropriate steps to achieve mining works, from simple to complex question. By using how they are distributed weights, leveling routes and networks can be partially solved by solving obtaining the same results as a whole. Also, for every situation can be evaluated by calculating the weighting coefficient accuracies of measurements determined.

3. REFERENCES

Dima, N., Pădure, I., *Mine surveying,* publisher Corvin, Deva, România, (1997).

Dima, ş.a., *Measurement error theory*, Universitas Publishing House, Petroşani, (1999).

Dima, N., *Geodesy,* Ed Universitas, Multan, (2005).

Dima, N., Herbei O, Vereș I., Bendea H., Filip L., *General Topography and elements of mining topography,* Universitas Publishing, (2005).

Filip L., Dima L., *Specialised mining topography*, Universitas Publishing House, Petrosani, (2014).

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THE ANALYSIS OF PRECISION IN ANGULAR INTERSECTIONS AND RESECTIONS

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Abstract: *Angular intersections are known for a long time ago but their use is often avoided because the large errors may occur in determining new points. However the use of intersections is very practical in engineering activity. Even accurate measuring instruments and experienced operators are used, the accuracy of such method especially depends of the geometry of placing new points compared to the old known points. This paper shows how to calculated the accuracy of determining a new point in the case of intersections or resections. Besides the analytical trait, the paper presents graphical representations showing that areas with accurate determinations and that areas with vague determinations. The paper is useful for practitioners who must decide depending on field conditions if they can use or not the intersections and resections method.*

Keywords: *the method of determining, accuracy, intersection, resection;*

1. INTRODUCTION

The methods used for control surveys are: Traversing; Least squares estimation of survey networks; Satellite position fixingș; Intersection and Resection. If the inaccessible point is to be coordinated from known points then the process is one of intersection. If the inaccessible point has known coordinates and the instrument station is to be coordinated then the process is one of resection.

Using these techniques, one can establish the coordinates of a point *P*, by observations to or from known points. These techniques are useful for obtaining the position of single points, to provide control for setting out or detail survey.

Intersections also applies in the mining area to determine the stability of extraction towers for measuring the slope edge in pits measuring stokpiles in waste dumps and warehouses.

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2. INTERSECTION

2.1. Equations used in the method

If it is considered known points A and B, of these point 1 will be determined by measuring angles α and β (fig.1).

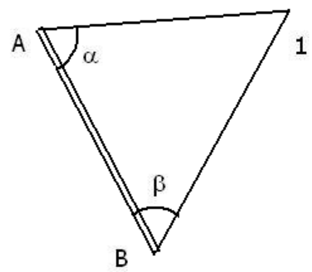


Figure 1. Intersection

Problem solving can be done either analytically or trigonometric. In analytical solving are calculated

$$x_1 = \frac{y_B - y_A + x_A tg(\theta_{AB} - \alpha) - x_B tg(\theta_{BA} + \beta)}{tg(\theta_{AB} - \alpha) - tg(\theta_{BA} + \beta)}$$
$$y_1 = \frac{x_B - x_A + y_A ctg(\theta_{AB} - \alpha) - y_B ctg(\theta_{BA} + \beta)}{ctg(\theta_{AB} - \alpha) - ctg(\theta_{BA} + \beta)} \quad (1)$$

The trigonometric solving uses sinus law and lead to the result

$$x_1 = x_A + AB\frac{\sin\beta}{\sin(\alpha+\beta)}\cos(\theta_{AB} - \alpha) \quad (2)$$
$$y_1 = y_A + AB\frac{\sin\beta}{\sin(\alpha+\beta)}\sin(\theta_{AB} - \alpha)$$

2.2. Evaluating the accuracy of determination

New point determination depends on the position of supporting points and also depends on angles measured.

$$x = f(x_A, y_A, x_B, y_B, \alpha, \beta) \quad (3)$$
$$y = g(x_A, y_A, x_B, y_B, \alpha, \beta)$$

If errors of support points are considered negligible, the error of point 1 determination can be expressed as:

$$m_{X1} = \pm \frac{m_\alpha}{\rho''} \sqrt{\left(\frac{\partial x}{\partial \alpha}\right)^2 + \left(\frac{\partial x}{\partial \beta}\right)^2} \qquad (4)$$

$$m_{Y1} = \pm \frac{m_\alpha}{\rho''} \sqrt{\left(\frac{\partial y}{\partial \alpha}\right)^2 + \left(\frac{\partial y}{\partial \beta}\right)^2}$$

It was considered that every angle is measured just as accurately, $m_\alpha = m_\beta$. Partial derivatives are:

$$\frac{\partial x_1}{\partial \alpha} = \frac{D_{A1}}{\cos\theta_{A1}(tg\theta_{A1} - tg\theta_{B1})} \qquad \frac{\partial x_1}{\partial \beta} = \frac{D_{B1}}{\cos\theta_{B1}(tg\theta_{A1} - tg\theta_{B1})} \qquad (5)$$

$$\frac{\partial y_1}{\partial \alpha} = \frac{D_{A1}}{\sin\theta_{A1}(ctg\theta_{A1} - ctg\theta_{B1})} \qquad \frac{\partial y_1}{\partial \beta} = \frac{D_{B1}}{\sin\theta_{B1}(ctg\theta_{A1} - ctg\theta_{B1})}$$

The expressions of errors on the two main directions X and Y are:

$$m_{X1} = \pm \frac{m_\alpha}{(tg\theta_{A1} - tg\theta_{B1})\rho''} \sqrt{\frac{D_{A1}^2}{\cos^2\theta_{A1}} + \frac{D_{B1}^2}{\cos^2\theta_{B1}}}$$

$$m_{Y1} = \pm \frac{m_\alpha}{(ctg\theta_{A1} - ctg\theta_{B1})\rho''} \sqrt{\frac{D_{A1}^2}{\sin^2\theta_{A1}} + \frac{D_{B1}^2}{\sin^2\theta_{B1}}} \qquad (6)$$

For the case of intersections resolved through trigonometric method, the relations expressing errors on the direction X, Y are:

$$m_{X1} = \pm \frac{m_\alpha}{\rho''} \frac{D_{AB}}{\sin^2(\alpha+\beta)} \sqrt{\sin^2\beta\cos^2(\theta_{AB}+\beta) + \sin^2\alpha\cos^2(\theta_{AB}-\alpha)} \qquad (7)$$

$$m_{Y1} = \pm \frac{m_\alpha}{\rho''} \frac{D_{AB}}{\sin^2(\alpha+\beta)} \sqrt{\sin^2\beta\sin^2(\theta_{AB}+\beta) + \sin^2\alpha\sin^2(\theta_{AB}-\alpha)}$$

Even though the obtained relations have different forms, them lead to the same results which show that it is not matter if the resolving of intersection is performed by analytical or trigonometric method.

In figures (2), (3), (4) are presented distributions of new point determination errors depending on the position of the new point compared to the old known point A and B.

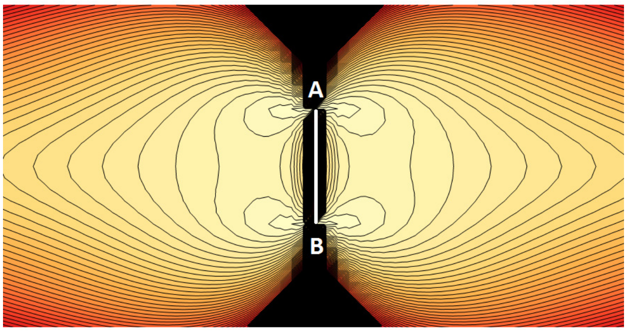


Figure 2. The distribution of errors in determining a new point on directions parallel to AB

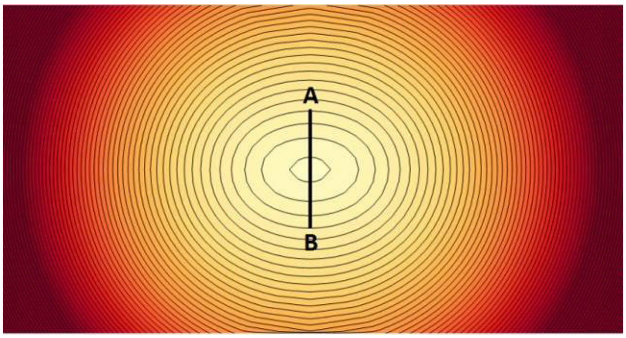


Figure 3. The distribution of errors in determining a new point on directions perpendicular to AB

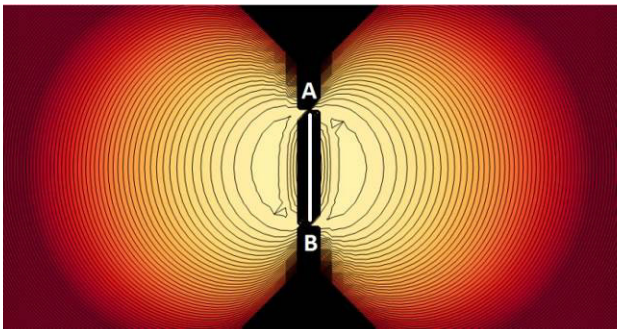


Figure 4. The distribution of mean square errors of determining a new point

Analyzing the figures you can see that there are areas in which determinations are more accurate in one direction or another direction are very imprecise. For example, if A and B are known pilasters on both sides of a dam, then through the angular intersection, displacements cross the dam can be measured very accurately (fig.3) while longitudinal movements are almost impossible to determine (fig.2).

3. RESECTIONS

3.1. Equations used in the method

Resection involves the angular measurement from *P* out to the known points *A*, *B*, *C* (*Fig.5*). It is an extremely useful technique for quickly fixing position. A variety of analytical methods is available for the solution of *P*: Snellius Pothenot, Delambre, Cassini, Colins etc. In the following it will approach the method of barycentre coordinates which is also known as `*Tienstra's method'*

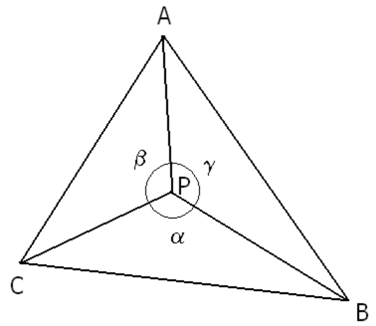


Figure 5. Resection

The resection can be solved by next relations:

$$X_P = \frac{P_A \cdot X_A + P_B \cdot X_B + P_C \cdot X_C}{P_A + P_B + P_C}$$

$$Y_P = \frac{P_A \cdot Y_A + P_B \cdot Y_B + P_C \cdot Y_C}{P_A + P_B + P_C} \tag{8}$$

where

$$P_A = \frac{1}{\mathrm{ctg}A - \mathrm{ctg}\alpha} \qquad P_B = \frac{1}{\mathrm{ctg}B - \mathrm{ctg}\beta} \qquad P_C = \frac{1}{\mathrm{ctg}C - \mathrm{ctg}\gamma} \tag{9}$$

3.1. Evaluating the accuracy of determination

The determination of the new poin P occurs with errors on X and Y directions and errors can be estimated with relations:

$$m_{XP} = \pm\sqrt{\left(\frac{\partial f}{\partial \alpha}\right)^2 \cdot m_\alpha^2 + \left(\frac{\partial f}{\partial \beta}\right)^2 \cdot m_\beta^2 + \left(\frac{\partial f}{\partial \gamma}\right)^2 \cdot m_\gamma^2} \tag{10}$$

$$m_{YP} = \pm\sqrt{\left(\frac{\partial g}{\partial \alpha}\right)^2 \cdot m_\alpha^2 + \left(\frac{\partial g}{\partial \beta}\right)^2 \cdot m_\beta^2 + \left(\frac{\partial g}{\partial \gamma}\right)^2 \cdot m_\gamma^2}$$

Where:

$$\frac{\partial f}{\partial \alpha} = \frac{(X_P - X_A) \cdot P_A^2}{(P_A + P_B + P_C) \cdot \sin^2\alpha} \cdot \frac{1}{\rho''}$$

$$\frac{\partial f}{\partial \beta} = \frac{(X_P - X_B) \cdot P_B^2}{(P_A + P_B + P_C) \cdot \sin^2\beta} \cdot \frac{1}{\rho''}$$

$$\frac{\partial f}{\partial \gamma} = \frac{(X_P - X_C) \cdot P_C^2}{(P_A + P_B + P_C) \cdot \sin^2\gamma} \cdot \frac{1}{\rho''}$$

$$\frac{\partial g}{\partial \alpha} = \frac{(Y_P - Y_A) \cdot P_A^2}{(P_A + P_B + P_C) \cdot \sin^2\alpha} \cdot \frac{1}{\rho''}$$

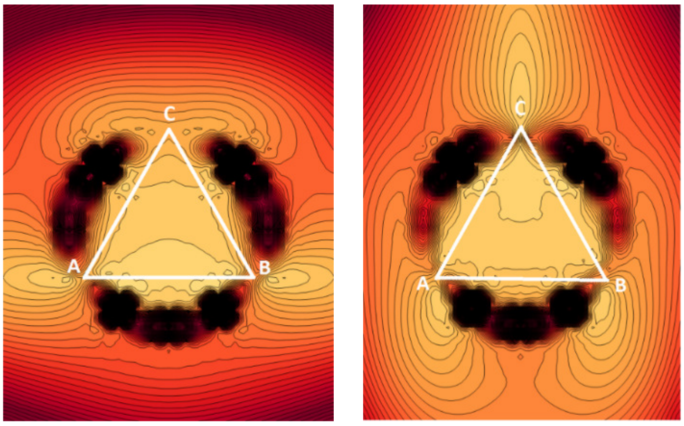
$$\frac{\partial g}{\partial \beta} = \frac{(Y_P - Y_B) \cdot P_B^2}{(P_A + P_B + P_C) \cdot \sin^2\beta} \cdot \frac{1}{\rho''}$$

$$\frac{\partial g}{\partial \gamma} = \frac{(Y_P - Y_C) \cdot P_C^2}{(P_A + P_B + P_C) \cdot \sin^2\gamma} \cdot \frac{1}{\rho''}$$

(11)

It has made graphical representation of the size errors of new point depending on its position relative to oldest known points. Representations were made in the following assumptions :

- It was considered that every angle is measured under the same conditions of precision
- It was considered that known points A, B, C form an aproxmativ equilateral triangle.



a) b)

Figure 6. Curves of equal error in determining a new point using resection -Tienstra's method; (a)The errors in the direction perpendicular to AB; (b) The errors in the

direction paralel to AB

It can be seen as the geometric area in which determined points have big errors is even the circle passing through the known points A, B, C and vicinity of that circle.

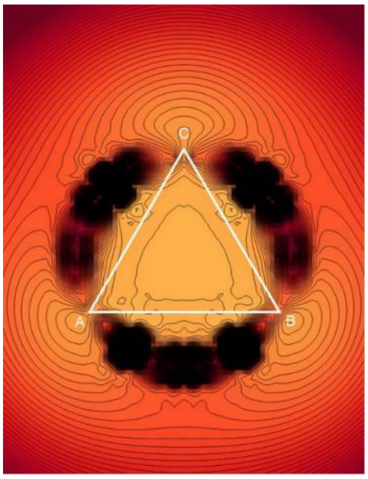


Figure 7. The distribution of mean square errors of determining a new point using resection

4. CONCLUSIONS

Knowing how the position of new point in relation with the position of oldest known point influences the accuracy of the outcome is beneficial to decide if the intersection /resection method is suitable or not for that case. Also possible errors can be calculated based on the angles measured in the field. Practitioners have to decide depending on field conditions if they can use or not the intersections and resections method.

5. REFERENCES

Dima, N., Pădure, I., *Mine surveying,* publisher Corvin, Deva, România, (1997).

Dima, N., et.al., *Measurement error theory*, Universitas Publishing House, Petroşani, (1999).

Dima, N., et.al., *General Topography and elements of mining topography,* Universitas Publishing, (2005).

Schofield, W., *Engineering Surveying*, Published by Elsevier Ltd, Sixth edition (2007).

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ASPECTS OF INTRODUCING THE CADASTER INFORMATION SYSTEM OF CULTURAL HERITAGE SITES WITHIN THE HISTORICAL MARAMURES

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COSTIN-SEBASTIAN MANU *
NICOLAE DIMA **

Abstract: *The cadaster of cultural heritage sites, as a subsystem of general cadaster in Romania, aims to record and realize a systematic inventory of the historical cultural sites. The Laws and specific regulations concerning the cultural heritage and cadaster provide the framework for the management of real estates listed as historical monuments. The paper proposes an overview of steps on realization of the cadaster information system of cultural heritage sites with representative aspects within the Maramures Depression, in northern part of Romania, as one of the richest in such cultural and historical sites. In conclusion, it is necessary to develop and implement a new software product for the integrated management of historical cultural sites to contribute to the sustainable development of the referred area.*

Keywords: *cadaster of cultural heritage sites, information system;*

1. PRODUCTION MANAGEMENT FEATURES OF LIGNITE MINING PITS

The cadastre reflects the relationship between the human being and space, being a product with multiple technical, legal, economic and also cultural valences. It has its origins in the political, social and economic history of the territories where it is applied. By its historicity, the cadastre becomes the witness of the spatio-temporal organization of the communities to whom it is addressed. The documents created by the cadastre works done in different historical times are sources of knowledge and documentation of the built space and of that space with various other destinations within the perimeters administered by the local communities whose space was being inventoried. In this respect, the cadastre of historical cultural heritage directly reflects the cultural valences of the cadastre. The importance of this subsystem of the general cadastre becomes evident during the devising of any sustainable development strategy at different levels: local, regional or national. In any such strategy, the protection and

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revaluation component becomes essential; assuming the development of specific strategies with projects and measures related to the protection, conservation and sustainable use of the built heritage in order to achieve sustainable territorial development.

Such a strategy of local development has been conceptualized starting from the needs and trends of local development by The Association of Intercommunity Development ”The Maramures Land” (AID), which represents an associative entity of the town halls from the historical Maramures, with the role of attracting grants and of achieving cross-border and international cooperation structures for fundraising and investment in the associated communities. This is the largest territorial association in the county, proposing opportunities for revitalizing Sighet as the center of the historic region of Maramures, organizing a platform that will become the driving force to initiate, implement and coordinate investment projects in the town halls which are members. One of the strategic priorities of the sustainable development strategy proposed by AID ”The Maramures Land” is the preservation and revitalization of local cultural heritage, especially those inscribed on the List of Historical Monuments 2010. It was took into account mainly the exploitation of the built heritage through urban revitalization projects, the exploitation of the archaeological heritage by providing access to archaeological sites and organizing outdoors exhibitions. To achieve this highly complex objective which requires multidisciplinary skills, it was necessary to outline an interdisciplinary research project with multiple objectives that constitute basic documentation for preparing the themes for designing the specifications, for purchasing the feasibility studies, for investment objectives relating to development works and documentation for approval of intervention works.

In this project it was proposed to be built an informational system of cadastre for the historical monuments in the mentioned area whose implementation was drawn up following the following plan:

- consultation of a specialized bibliography and the pre-establishments of a set of specific conceptual delimitations;
- documentation regarding the laws concerning the legal status of the historical monuments and also concerning the introduction of the specialized cadastre;
- evaluating the current state of the documentation of monuments, ensembles and historical sites in terms of management of these categories of objectives;
- documenting the progress in achieving the cadastre of historical monuments;
- developing a working methodology to achieve topo-cadastral work in accordance with the regulations in force;
- developing a methodology for obtaining and editing final results;
- the need for making a software for the management of historical monuments.

1.The consultation of specialized bibliography and the pre-establishments of a set of specific conceptual delimitations.

The premises of the research started from the first conceptual delimitations provided in Romanian legislation, namely the definitions of art. 3 of Law no. 422/2001 on the protection of historical monuments.

a)monument – a building or part of a building, together with the equipment, artistic components, interior or exterior furnishing elements that are part of these, as well as commemorative and funerary artwork, for public forum, together with the topographically delimited adjoining land, which is of cultural historical testimonies from an architectural, archaeological, historical, artistic, ethnographic, religious, social, scientific or technical point of view;

b)ensemble – a coherent group in terms of cultural, historical, architectural, urban, rural or museum construction, which together with the adjoining land forms a topographically defined unit which constitutes a cultural-historical witness significant from an architectural, town planning, archaeological, historical, artistic, ethnographic, religious, social, scientific or technical point of view;

c)site – a piece of land topographically delimited including those natural human creations that are cultural historical testimonies in terms of architecture, urban planning, archaeological, historical, artistic, ethnographic, religious, social, scientific, technical or cultural landscape.

According to the meanings of legal definitions, the reference works consulted and the proposed for consultation report to the urban and rural architecture in Maramures, the museology and ethnographic museotechnique, history and memoirs of the mentioned area, the archaeological research and specialized archaeological repertoires drawn on localities, bibliography on the preparation of planning documents, as well as works related to the making of the historical monuments cadastre. Wherever possible, there was retained reference works of renowned authors for each of the areas listed. References and sources proposed for consultation give a horizon on the current state of knowledge of the issues referred to members of the mentioned association.

2.The documentation regarding the laws concerning the legal status of the historical monuments, and the introduction of the specialized cadastre. In this respect, we took into consideration the following categories of legislation:

- the European law and European conventions to which Romania joined, as well as the charters, resolutions, declarations and recommendations of specialized international bodies agreed by UN,-UNESCO and CE are also treated as international law although not normative;
- legislation on the legal regime of the monuments, ensembles and archaeological and historical sites available online on the website www.cimec.ro;
- laws concerning the functioning of legal entities responsible for the management of historic monuments available online on the website mentioned; laws on urban and spatial planning available on the website www. mdrap.ro;
- legislation regulating the introduction of the cadastre in Romania, available on the site ANCPI;

3.Evaluating the current state of the documentation of monuments, ensembles and historical sites in terms of management of these categories of objectives. In achieving the proposed objective we consulted the existing documents at Maramures County Directorate for Culture, Cults and Heritage which holds a small part of records files for monuments, ensembles and historical sites listed on LMI 2010. The ranking, representing the legal procedure by which a building access regime for the protection of historical monuments, attested by its inclusion in the List of Historical Monuments, was done on the basis of documents that were submitted to the National Commission for Historical Monuments of the Ministry of Culture and they were not available for documentation at this stage of research.

According to article of the Law no. 422/2001 on the protection of historical monuments, the filing folder includes mainly:

- the technical documentation containing the analytical data sheet inventory, situation plans, a survey of the current building, a photo documentary with interior and the exterior of the building, the surroundings of the site and, where appropriate, data on the use of property and the technical expertise;
- the historical documentation, namely the historical-architectural study drawn up by a specialist certified by the Ministry of Culture in the field of historical monuments;
- the documentation regarding the legal situation containing copies of documents confirming ownership or other real rights over the property or documents issued by local government authorities, together with copies of the cadastral plan of the land register. As a result, a significant amount of the required documentation to make the informational system of the monuments, ensembles and historical sites of mentioned area are founded in these files. Therefore, some of these documents, for reasons of efficiency, can be updated by project promoters with the agreement of the specialized structures of the Ministry of Culture. By consulting the List of Historical Monuments, LMI 2010, the result is that the historical Maramures area comprises a relatively large number (over 200) of monuments, buildings and historic sites and Sighetu Marmatiei is by far on the first place with more than 100 such targets.

4. Documenting the progress in achieving the cadastre of historical monuments. To achieve this objective of the research, given the large volume of information that is supposed to be managed, we can at this stage propose a methodology of documentation that can be applied in specific cases. Thus, for the sporadic cadastral works relating the notation of buildings qualified as historical monuments, it is necessary to consult the Eterra geoportal of the National Agency for Cadastre and Land Registration (ANCPI), with the last version, Eterra 3, in which the authorized people to perform cadastral works have direct access to the cadastral plan and the information in the land books (within certain limits), both collections of data being updated and available in real time. Thus the authorized person can proceed with the demarcation and communication of an affected area of interest of a historical monument, drawing a polygon within the cadastral plan from the system representing the focused area, communicating the request to the staff of the territorial Cadastre and Land Registration Office BCPI to process the application. The areas of interest can be identified using the eGISpat application. The EGISpat program, conducted through the Ministry of Culture in 2005 to achieve a geographic information system (GIS) for real protection of national cultural heritage (archeology and historical monuments), was the result of a partnership between the Ministry of Culture and ESRI Romania. eGISpat is,

as is described by ANCPI, a comprehensive database of registration of the immovable property which stores, analyzes and correlates multiple data types, spatial, non-spatial, cartographic, photographic, etc., in order to obtain the necessary information for decision making in management activities, restoration, conservation and heritage building. For the purposes of information on the list of historical monuments and their location on the map, it can be viewed and used by the general public as an interactive online applications with capabilities of searching a historical monument by the following criteria: LMI 2010 code, city, address, timing, selection by the criterion county and navigation and identification directly on the map using specific instruments. The monuments, ensembles and historical sites are represented as a vector polygon perimeters placed on geographic coordinates. The legend allows loading and unloading the map by checking the thematic layers that compose it: LMI (warning that there are objectives registered in LMI in that locality), ensembles, monuments, sites, inventory, roads, rivers, communes, counties, and towns, each with its distinctive representation. The data provided by Eterra 3 refers to the related works for the registration of a building in the integrated system based on the sporadic works of cadastre and land registry, at the request of some interested people or upon notification by the competent authorities. In case the concerned area is not contained in such records, there is a need of consulting the existing cadastral documents in the current territorial archives BCPI or the National Archives, respectively maps, cadastral plans, land registers and books for the areas around the historical monuments. This procedure can be completed by georeferencing the scanned maps by using a minimum of four checkpoints on the ground and used to determine the location of the boundaries of historical monument buildings. The document also includes other specialized cadastres, an urban cadastre being, for example, developed for part of the historic center of Sighetu Marmaţiei, and for forest areas that include landscaped areas within the surfaces there are required silvic plans and possibly parceled description for the studied area.

5. Developing a working methodology to achieve topo-cadastral work in accordance with the regulations in force. The proposed methodology aims to establish working procedures to be followed in scoring in the land the buildings that are listed as historical monuments. Registering is according to the article 18 from the Annex of Order 700 from 2015 of the ANCPI Director, an entry through which acts, legal facts or legal relations regarding personal rights, status or capacity of persons, in relation to buildings recorded in the land register become opposable to third parties or they are included with informative effect. In the same law is assigned that the registration of the historic or archaeological site quality of a real estate property is nonrestrictive achieved at the request of any interested person (the land owner registered within the land book, bearers of other real rights, the Romanian Government, Ministry of Culture and the county offices for culture and cultural heritage, respectively Bucharest similar offices, the National Commission for Historical Monuments, National Archaeology Commission, the National Commission Museums and Collections, as well as

associations and foundations that have as object of activity protecting the historical monuments according to the law or the articles of association, based on the classifying order issued by the Minister of Culture and Religious Affairs and published in the Official Monitor of Romania. The historic monument attribute of a real estate property, in accordance with Law no. 422/2001 on the protection of historical monuments, had to be registered by the owner in the Land Registry, without charge, within 30 days from the date of registration of the Order of Ranking in the Official Monitor of Romania, Part I. In general, the cadastral documentation prepared for the registration in the land registry in the case of historical monuments and archaeological sites are similar of those first the first registration in the integrated system of cadastre and land registry.

Making the cadastral documentation involves the following steps:

- Identification of the location of the real estate on its natural or conventional limits prior to work execution followed by technical documentation which comprises sampling the current situation, according to the records held by the owner, in relation to the existing site elements and also requesting updated information from the database of Territorial Office / District Office.
- Implementation of field and office works involve choosing the method of work followed by the surveying woks to determine the configuration, location and size of the real estate, achieving connection the surveying networks for thickening and lifting, lifting the planimetric cadaster details located on the boundary and inside the real estate, collecting attributes, verifications and validating existing data. The parcels components of the real estate that have different categories of use will be determined through expeditious methods. The permanent buildings located within the real estate will be represented by their ground level footprint. The kind of fences will also be written down.
- Drawing the analogue and digital documentation –. The digital part will include the site plan and boundaries and also the cpxml file. The analogue file will include a number of standard forms, copy of the classification order, copy of the land book information excerpt real, the coordination inventory of stationing points, the analytical calculation of the land, the technical memorials, topographical description, the area plan and delimitation on an appropriate scale of real estate, surveys of buildings, where appropriate, the framing plan of the real estate, so the property can be located and a property statement regarding the identification of the limits of the measured real estate. From the field practice there can be seen the precarious state or even the lack of geodetic or topographic points from the thickening geodetic network across a real estate classified as a heritage site or near it. These shortcomings can be filled using GPS technology to determine new points using the static method with increased residence time. On these new stationing points determined points, a total station could be set to determine new thickening points through the radiation method. The property regime of the real estates included in the List of historical and archaeological sites is diverse and it creates difficulties in achieving the subsystem of historical sites cadastre. A large part of them are private real estate with various land use categories but

formally classified as built historical monuments, architectural ensembles or archaeological sites. The state also owns part of such real estate included in the public or private domain of the territorial administrative units, in some cases the operative management right being entrusted to local councils or museums within the area. Others are owned by institutions of education, culture or religious ones and a small number of such sites are located within the management units of forestry areas. To be noted that Romsilva has introduced a new concept in the forest management in the FSC forest certification system namely high conservation value forests (HCVF) based on six criteria established by the FSC standard. According to the sixth criteria of the mentioned standard, the management of forest areas with essential value for preserving the cultural identity of a community or area, so those areas comprising their perimeter historical monuments or archaeological sites too, is aimed at improving conservation attributes considered at the time of determining these HCVF sites, prohibiting or limiting any forest works.

6. Developing a methodology for obtaining and editing final results. The registering procedure in the Land Book of the historical monument is an approach that has its final aim its inclusion in the integrated system of cadastre and land registry. The drawn up documentation for each real estate classified as a historical monument or archaeological site is subject to approval procedure and reception of specialized cadastral works with the award of a cadastral number. The elaborated result with legal value in this case is the land book information excerpt issued following the opening of a new entry in the land registry. For the mentioned research project there was proposed the drawing of new final works to help the potential applicants for funding applications.

- A code of built heritage for the city of Sighetu Marmatiei which will contain precise regulations establishing the buffer zone for historical monuments, the approval of intervention works as well as responsibilities and recommendations for local urban planning regulations. 3D models drawn in CAD environment for the improvement of the quality of documenting handouts. This requires the introduction of new technologies in the process of documenting the historical monuments such as using digital photogrammetry as well as some specialized software products in digital imaging and processing into formats that can be used in the CAD environment. One such software that does not require large budgetary effort is Photomodeler. The result will be getting the 3D model of the building heritage.

7. The need for making a software for the management of historical monuments. This finding derived from the addressed issues and from the questions of the research is also the main conclusion of the research. At the national level there is no software for the integrated management of historical monuments and the created documents only serve to certain punctual objectives. The EGISpat program mentioned above partially covers the management needs of historical monuments although it is made on GIS platform with the ability to integrate and correlate spatial data and attribute data. It was created as a pilot project of digital mapping of historical

monuments and it only covers limited user needs, serving as a medium for public information on the location and configuration of the buildings included in the List of Historical Monuments. From the perspective of the management of monuments, ensembles and historical sites, the realization of a computerized land records on buildings classified as historical monuments is a tool for their effective management. The validation of the research results will be considered as accomplished with the development of the proposed integrated strategy developed by AID ”The Maramures Land”

REFERENCES

Dima, N., Herbei, O., Bendea, H., Vereş, I., Libardi, Z., *Tehnici și tehnologii moderne în lucrările de cadastru*, Petroșani (2003).

Tămâioagă, G., Tămâioagă, D., *Cadastrul general și cadastrele de specialitate*, Editura Matrix Rom, Bucureşti, (2005).

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IMPORTANCE AND THE PARTICULARITIES OF INTRODUCING SYSTEMATIC CADASTRE IN ROMÂNIA

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Abstract: *The work is performed on a historical analysis of cadastre and real estate promotional systems used in Romania. Also presented specific issues and characteristics in order to find solutions for introducing systematic cadastre. It will develop a unified system of registration of technical, legal and economic buildings nationwide.*

Keywords: *reinstating the possession, owner, Property Title, topographic measurements*

1. INTRODUCTION

The systematic cadastre in Romania is particularly important to be realized as soon as possible since its absence generates big problems at the society level, either economic problems, regarding the realization of infrastructure, or social problems, all having a common denominator, namely the absence of systematic cadastre.

The question raised is why is it so difficult to realize the registration of the entire country? The answer is extremely complex and, in order to be as accurate as possible and to have a clearer image of the existing problems in Romania, an analysis from a historic point of view must be done regarding the cadastral and land registration systems used in Romania over the years.

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1.1. Specifications regarding the content

The first major issue that caused big problems regarding the standardization of the work mode at a national level consisted in the fact that in Romania two cadastral and real estate systems were used. In Transylvania, Banat and Northern Bukovina, it was used the Cadastral Register system was used, based at the beginning on the provisions of the Austrian Civil Code and then on the Decree Law 115/1938, and in Wallachia, Moldavia and Dobrogea, it was used a system of inscriptions transcriptions.

The major difference between the two concepts consists in the fact that, in the case of the Cadastral Register, the base entity which is followed is the property, while in the system of inscriptions transcriptions the owner is followed.

These systems have been rigorously kept until 1950. After this year abusive collectivization and confiscation of properties began, there was no longer a focus on private property, on the realization of a record system for it and on keeping this record up to date. Thus, it ended up that during this period 1950-1990 the old records to be updated only within the built-up areas and even here with many gaps and inaccuracies and sporadically in outside built-up areas where cooperatization did not take place.

Over the years, there have been issued also other laws and decrees that have confused even more the situation of property and have generated great confusion. Such cases would be the Law 2/1968 regarding the administrative territorial division and delimitation of Romania. This law generated great confusion that persists even today, because when the law was issued, it was not accompanied also by a graphic annex showing the territory's extension of each Administrative Territorial Unit founded by this law. The lack of this graphic annex led to great disputes between Administrative Territorial Units, some of these disputes being unsolved even today.

After 1990, together with the restoration of a democratic new regime and the adoption of a new constitution for Romanian, constitution that guarantees the right to property, a greater emphasis started again to be put on private property, and of course, it began to be felt the need to realize a record system of these properties both to provide land registration and also to achieve a fair and equitable taxation of each property.

The first law with a major impact on the evolution of the property system in Romania was Law 18/1991 regarding the restitution of abusively confiscated properties by the communist regime. The extremely faulty and uneven mode in which this law was applied, as well as some of its questionable provisions and the lack of a clear property record from the previous years led to the creation of a chaotic situation.

The first law that regulated cadastral activity and in which the realization of the systematic cadastre in Romania was stipulated was Law 7/1996. The most important provision regarding for the standardization of cadastral activity at a national level was the adoption of the land registration system based on Cadastral Registers. After the appearance of this law the old records from the Cadastral Register done based on the Decree Law 115/1938 were recognized and considered active Cadastral Register, and for properties that were retroceded and had title deeds issued they were beginning to be registered in the Cadastral Register on request based on a cadastral documentation, the so-called sporadic cadastre.

Things became even more complicated with the emergence of two other laws regarding property restoration to former owners: Law 1/2000 and 247/2005 which generated very many problems in the property system of Romania.

Some of these regarded the way local committees understood to implement the provisions of these laws and the way property titles were issued. For example, in very many communes property titles were issued without drawing up a parcel plan to make possible the individualization of each parcel written in the title deed. There are many situations when the titles are written with errors regarding the location or when the location is not even described at all on the back of the title. There are also situations when even if the location is described it is very difficult to be identified because it was not made in accordance with a graphic plan that could lead to the identification of the parcel written in the title.

Going back in time to the Law 2/1968 and to the problems caused by the lack of the graphic annex, I was saying that it generated major disputes and these were extremely pronounced and visible after 1991 when the property restoration began because, due to some misunderstandings and sometimes errors, situations were created at the border between communes or cities it happened quite often that a commune issued title deeds on the other's territory or even worse because of the misunderstandings regarding the border and of the faulty drawing up of restoration documents, a point was reached where on the same location both communes issued title deeds, creating real of title deeds.

Also due to the way in which title deeds were issued, countless situations appeared of dispute and real overlaps between owners who received by title deeds some buildings and terrains administrated by various institutions and state authorities. Such examples would be situations when due to lack of measurements on field in order to draw parcel plans and subsequently to vest in possession and issue title deeds, there are cases of full or partial overlaps between national, county or communal roads and the properties recorded in the title deeds. Situations of this kind are found also in the case of some overlaps with the railways area in the riverbeds, etc.

Also in the outside built-up areas where cooperatization did not take place, there exists in a particular situation because here a large number people have not made a demand for the issuance of a title deed since they considered that the property was not taken from them and they possessed it continuously from generation to generation. If in the old Cadastral Register area (Transylvania, Banat and Northern Bukovina) with little effort the landowners can be identified also based on legacies, the situation being brought up to date, in the inscriptions transcriptions area this is almost impossible and so there is a great problem regarding the property documents belonging to the citizens in these areas.

But even there where documents exist and these are not up to date and several succession steps must be followed, often taxes and duties to be paid exceed the value of the property and the owner prefers to remain without documents on that property. I have listed a few major problems that somehow are general being found almost everywhere in the country, but besides these, in outside built-up areas appear many other particular problems that differ from case to case.

Within the built-up areas, if it were be to analyzed according to the principle of the old Cadastral Register, then in the area where this existed was somewhat kept up to date also during the communist period, one of the major problems was that this up to date keeping was done only in the register and not graphically by operating also on the plans possible changes occurred in the structure of the property by unifying, dismemberment, building operations, etc.

In the area where before the appearance of the Law 7/1996 besides the fact that there was no graphic record of the properties written in the inscriptions transcriptions records, in big the cities there is a major problem because blocks were not divided into pieces before the state sold them to the tenants and hence a number of errors and misinterpretations appeared regarding the way these flats should have been registered in the Cadastral Register. Also within the built-up areas of the big cities and not only particular problems arise regarding the large industrial premises, in their inventory and registration in the Cadastral Register of the public domain, etc. Like in the case of outside built-up areas, also within the built-up areas specific problems appear particularized on small groups of properties and to which solutions must be found within the works of systematic cadastre.

In Romania, in 2009, an integrated informatics system of cadastre and Cadastral Register called Ettera were implemented. Along with its implementation and the issuance by the Agency for Cadastre and Land Registration of some regulations regarding the realization of cadastral works and registration in the Cadastral Register, all the problems started to appear and very many situations of virtual or real overlapping have been identified.

If in the case of real overlapping problems occurred due to the existence of two documents on the same property, in the case of virtual overlapping the situation was generated by the measurement and calculation errors, by the persons who made those cadastral works.

In summary, we could say that, the major problems that will have to be solved with the systematic cadastral works are:

- Completion of problems regarding administrative territorial boundaries.
- Realization of parcel plans in order to correlate them with the title deeds.
- Recording the possession also by the effect of the law or by issuing a certificate

of possession transformation into property, to be solved also the problem of those who own property and cannot prove with documents their ownership over these properties.

- Solving virtual ovelaps generated by the works of sporadic cadastre
- Finding of some solutions regarding the realization as expeditious, but fair and

accurate of the works of blocks’ division into pieces in the big cities.

- Standardization of the working mode at national level.

All the issues listed above, as well as the lack of a cadastre at a national level, lead to big problems, regarding the realization of the infrastructure to create subsequent economic benefits, the absorption of funds. There are big problems regarding efficient administration in terms of agricultural land, the realization of a fair and equitable tax base for each citizen based on the most accurate information.

Today in Romania, there are registered by almost exclusively sporadic cadastral works approximately 19% of the total number of existing properties in the country and works of systematic cadastre have been started in 50 communes under the CEZAR project.

It is expected that, under the National Cadastre Program approved by the government, during the period 2015-2023 the systematic cadastre of the entire country to be fully realized.

2. CONCLUSION

The work is divided into three parts, in which we performed a historical analysis of past and present cadastre and land registration in Romania and assessed the issues identified related to certain situations that need solving in the project of introducing systematic cadastre.

The first part presents a brief analysis of the history of cadastre and land registration records, which were made in Romania over time, starting from the specific peculiarities of different areas of the country and in different periods of time. Next, we have assessed the current situation existing after 1996, when by law, the land register system was adopted at a national level as a unique cadastral and land registration system compulsory throughout the country. Here, we have considered the elements specific to the sporadic recordings made in these 20 years and the issues that were found and which should be considered when introducing systematic cadastre.

In the final part, we have analysed situations still unresolved in the cadastre works, situations arising from historical peculiarities of the cadastral works made in Romania over time and possible alternatives to solve them. In the end, we have presented the benefits and importance of introducing systematic cadastre at a national level.

3. REFERENCES

[1] **Bârliba L.L., Popescu A.C., Bârliba C.,** *Elements of course cadaster-notes and practical works,* Publisher Eurobit, Timişoara, România, 2013.

[2] **Ciolac V., Roşu C., Bârliba L., Popescu C., Babuca N., Bârliba C., Nistor E.,** *The unitary system of digital archives and land register in Romania - the electronic land register.* International Multidisciplinary 13th Scientific GeoConference

SGEM 2013, 16-22 june, ALBENA-BULGARIA, Conference Proceedings, Vol.I, 997-1004pp, ISSN 1314-2704, ISBN 978-954-91818-9-0.
[3] **Nemeş I., Bârliba L.L., Bârliba C.,** *Evolution of real estate advertising in Romania.* International Multidisciplinary 12th Scientific GeoConference SGEM 2012, 17-23 june, ALBENA-BULGARIA**,** Conference Proceedings, Vol.II,1035-1040pp, ISSN 1314-2704.
Indexing by ISI Web of Knowledge, Web of Science, Thomson Reuters, ELSEVIER products, SCOPUS, CrossRef, EBSCO, ProQuest, Google Scholar, Mendeley, CiteUlike, CrossRef Citedby Linking, British Library.
[4] **Ienciu I., Tudorascu M., Oprea L.,** *The realization of extrajudicial cadastral expertise in România,* International Multidisciplinary 14th Scientific GeoConference SGEM 2014, ALBENA-BULGARIA**,** Conference Proceedings,Vol.II, 575-583pp, ISSN 1314-2704.

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THE ANALYSIS OF THREE-DIMENSIONAL BEHAVIOR OF OBJECTIVES IN MINING INDUSTRY USING THE GLOBAL TEST OF CONGRUENCE WITH TWO STAGES OF MEASUREMENT. LOCATING DEFORMATIONS USING STATISTICAL TESTS

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Abstract: *Monitoring three-dimensional behavior of industrial objectives can be achieved through rigorous mathematical processing using the Global Test of Congruence, which determines whether or not deformations appear among several stages of measurements. Locating deformations in the geodetic network is achieved by using statistical tests, Student's t-test or F Multiple statistical test.*

Keywords: *Geodesy, the least squares method, the theory of errors, the Global Test of Congruence, Student's t-test, F test*

1. INTRODUCTION

Except the obvious cases where macro-deformations occur, there are special circumstances where it is desirable to highlight whether deformations exist or not for strategic industrial objectives, sometimes in the range of millimeters, and also locating those deformations in the measured geodetic network. In order to achieve this and in interests of accuracy, 3D position of points is studied separately in terms of planimetry and altimetry due to different surveying instruments that are currently used. For planimetric positioning using geodetic equipment such as total stations, planimetric coordinates are indirectly determined in the local system or Stereographic 1970. This equipment often does not meet the accuracy requirements for elevation set by the beneficiary, moreover the trigonometric levelling method used in determining position in the vertical plane and elevation is not sufficiently qualitative, therefore geometric

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levelling is used as a working method with optical levels or electronic equipment, for determining level differences and distances and then indirectly elevation.

2. DETERMINING DEFORMATIONS USING THE GLOBAL TEST OF CONGRUENCE

For determining planimetric and altimetric deformations, the Global test of Congruence is being used. After conducting measurements, the result consists in complex geometric figures. By studying these figures among several stages of measurements and their congruence, we may be able to rigorously determine whether or not there is a displacement of the measured points. The difference between the parameters among at least two stages of measurements must be in a safety limit. The safety limit shall be determined according to the standard empirical error of the measurements. In each stage of the observations, the functional-stochastic model for processing is determined, in most cases in current practice as for the indirect measurements. The functional model with the default hypothesis:

$$L_i + v_i = A_i + x_i; i = \overline{1,n} \quad (1)$$

$$\text{matrix} \quad \begin{pmatrix} L_1 \\ ... \\ L_n \end{pmatrix} + \begin{pmatrix} v_1 \\ ... \\ v_n \end{pmatrix} = \begin{pmatrix} A_1 & 0 & 0 \\ 0 & ... & 0 \\ 0 & 0 & A_n \end{pmatrix} * \begin{pmatrix} x_1 \\ ... \\ x_n \end{pmatrix} \quad (2)$$

Where: L_i - vector of measurements; v_i - vector of error corrections; A_i - matrix of unknown parameters coefficients; x_i - vector of unknown parameters. Stochastic model:

$$\sum L_i = \sigma_0^2 * Q_i \qquad \text{where: } \sum L_i \text{ variance-covariance matrix} \quad (3)$$

Q_i - cofactor matrix, diagonal matrix with "0" displayed on the secondary diagonal, which indicates that the measurements are independent, uncorrelated. We impose $\sigma_0 = \rho$", therefore we impose the measurement accuracy by choosing the working method and the corresponding equipment. In this case, Stonex R2+ total station has the accuracy in determining horizontal angular directions $\rho" = 2"$, so $\sigma_0 = 2"$. For altimetry Bosch GOL32 Professional level has the accuracy of 1mm/ km in geometric levelling, so $\sigma_0 = 1mm$. The processing is carried out under the minimum imposed condition:

$$v^T * P * v \rightarrow \min \quad (4)$$

$$P_i = Q_i^{-1} \quad (5)$$

Where: P_i - weight matrix and Q_i^{-1} - inverse of cofactor matrix

We impose a null hypothesis:

$$\{H_0\} : E\{s_{0_i}{}^2\} = E\{s_{0_n}{}^2\} = \sigma_0{}^2 \tag{6}$$

Where $s_{0_i}{}^2$ - standard theoretical deviation corresponding to the stage i.

The alternative hypothesis is:

$$\{H_1\} : E\{s_{0_i}{}^2\} \neq E\{s_{0_n}{}^2\} \neq \sigma_0{}^2 \tag{7}$$

$$F_{practic} = \frac{s_{0_i}{}^2}{s_{0_n}{}^2} \tag{8}$$

$$F_{theoretic} = F_{f_1, f_2, \alpha} \tag{9}$$

Where: f_1, f_2 - degrees of freedom; α - risk coefficient, $\alpha = 5\%$

The decision as a result of applying the statistical test will be 1-α , so 100% - 5% = 95 % mathematical probability n. The decision of the test:

$$F_{practic} > F_{theoretic} \tag{10}$$

So: The hypothesis $\{H_0\}$is false → the hypothesis$\{H_1\}$ is the true

$$F_{practic} \leq F_{theoretic} \tag{11}$$

So: The hypothesis $\{H_0\}$is true → the hypothesis $\{H_1\}$ is false, we can apply the Global test of Congruence.

Processing will be carried out considering a free network, the most common case in current practice:

$$X = (A^T * P * A) * (A^T * P * l) \tag{12}$$

$$A^T * P * A = N \tag{13}$$

Using a special inverse

$$A^T * P * A = n \tag{14}$$

Considering stage i measurements:

$$x_i = \mathrm{N_i}^+ * n_i \tag{15}$$

$$\Sigma_X = \sigma_0{}^2 * Q_X \tag{16}$$

Σ_X - covariance matrix

$$Q_X = N_i{}^+ = P_i^{-1} \tag{17}$$

$$s_{0_i}{}^2 = \frac{v^T * P * v}{n_i - u_i + d} = \frac{\Omega_i}{f_i} \tag{18}$$

Where: n_i - the number of equations for stage i; u_i - the number of unknowns in stage i; d - datum defect

f_i - degrees of freedom, redundancy

$$s_0^{\ 2} = \frac{\sum \Omega_i}{\sum f_i} = \frac{\Omega}{f} \tag{19}$$

$s_{0_i}^{\ 2}$ is the standard empirical deviation of the deformation model. For applying any statistical test, we must establish work hypotheses:

$$B * X = W \tag{20}$$

The null hypothesis for Global test of Congruence:

$$\{H_0\} : E\{X_i\} = E\{X_n\} \Leftrightarrow E\{X_n\} - E\{X_i\} = 0 \tag{21}$$

$$\begin{pmatrix} -I & I \end{pmatrix} * \begin{pmatrix} x_i \\ x_n \end{pmatrix} = B * X = W = 0 \tag{22}$$

$$B = \begin{pmatrix} -I & I \end{pmatrix} \text{ - configuration matrix} \tag{23}$$

$$\Omega_H = \Omega + R \tag{24}$$

Ω_H - the sum of square errors influenced by statistical hypothesis; Ω - the sum of initial statistical square errors, not influenced by linear hypothesis; R - the sum of additional statistical square errors, which we have already introduced, the influence of the linear hypothesis. We want to assess the size of R, as the error of a function of indirectly determined quantities (the theory of error):

$$R = (B_X - W)^T * \left[B * \left(A^T * P * A\right)^+ * B^T\right]^+ * (B_X - W) \tag{25}$$

$$R = (X_n - X_i)^T * \left(N_i^{\ +} + N_n^{\ +}\right) * (N_n - N_i) \tag{26}$$

$$(N_n - N_i) = d \text{ - vector of discrepancies} \tag{27}$$

$$\left(A_i^{\ T} * P_i * A_i\right)^{-1} + \left(A_n^{\ T} * P_n * A_n\right)^{-1} = N_i^{\ +} + N_n^{\ +} = Q_{dd}^{\ +} \tag{28}$$

$Q_{dd}^{\ +}$ -cofactor matrix corresponding to the vector of discrepancies, d

$$R = d^t * Q_{dd}^{\ +} * d \tag{29}$$

$$d = X_2 - X_1 \tag{30}$$

$$\text{h = n - d} \tag{31}$$

h - the rank of the matrix Q - the same in all stages; d - defect of reference data

The size of the test procedures for a two-step measurements:

$$F = \frac{R}{s_0^{\ 2} * h} = \frac{d^T * Q_{dd}^{\ +} * d}{\frac{v^T * P * v}{n_i - u_i + d} * h} = \frac{d^T * Q_{dd}^{\ +} * d}{\frac{v^T * P * v}{f_i} * h} = \frac{d^T * Q_{dd}^{\ +} * d}{v^T * P * v} * \frac{f_i}{h} \tag{32}$$

Where: $\dfrac{d^T * Q_{dd}^{\ +} * d}{v^T * P * v}$ is a fraction of squares.

The size of the test has Fisher distribution with f degrees of freedom as numerator and h degrees of freedom in the denominator. The probability is the following:

$$P\{F \le F_{h,f,1-\alpha} | H_0\} = \alpha \tag{33}$$

Where:
F - the practical value; $F_{h,f,1-\alpha}$ - the theoretical value; H_0 - the null hypothesis; α - the probability.

The decision of the statistical test is the following:

$$F \le F_{h,f,1-\alpha} \rightarrow (H_0) \text{is true } (H_0): E\{X_i\} = E\{X_n\} \Leftrightarrow E\{X_n\} - E\{X_i\} = 0 \quad (34)$$

so there is no deformation in the network.

F > $F_{h,f,1-\alpha} \rightarrow (H_0)$ False, it is necessary to a alternative hypothesis H_1

$$(H_1): E\{X_i\} \ne E\{X_n\} \Leftrightarrow E\{X_n\} - E\{X_i\} \ne 0 \quad (35)$$

so there is deformation in the network. In order for the Global test of Congruence to determine whether there are deformations in the network, the following conditions have to be met:

- For both stages of measurements, the same geodetic datum must be used in processing;
- For all the stages of measurements the reference defect must be the same, or the datum defect; considering the geometric leveling d=1, trilateration d = 3, triangulation d = 4, photogrammetry d = 7;
- The configuration of the networks should be the same on both stages, the ideal case; if this condition cannot be met, then the configuration matrix minimizes as a whole or partially;
- The standard theoretical deviation should be the same in all the stages.

3. LOCATING DEFORMATION

For locating deformations, mostly for the displaced points of the network, statistical tests are used, such as the Student's Statistical t- Test or F-test.

3.1. Student's Statistical t- test

$$s_j = s_0 * \sqrt{Q_{jj}} \quad (36)$$

The previous equation determines the standard empirical deviation of the elements contained in the vector of discrepancies d, as determined by 30) Q_{jj} - the components of the main diagonal of cofactor matrix vector d, Q_{dd}

$$Q_{dd}^{+} = \begin{pmatrix} Q_{11} & & & \\ & Q_{22} & & \\ & & \dots & \\ & & & Q_{nn} \end{pmatrix} \quad (37)$$

$$t_j = \frac{d_j}{s_j}; j = \overline{1, n} \tag{38}$$

Considering a planimetric network, the number of points in the network is $\frac{n}{2}$, for a network in space the number of points in the network is $\frac{n}{3}$. The null hypothesis

$$\{H_0\} : E\{d_j\} = 0 \tag{39}$$

The probability that the null hypothesis is satisfied:

$$P\{t_1 \le t_{\lim} / t_1 \le t_{\lim} / ... / t_n \le t_{\lim} | H_0\} = 1 - \alpha \tag{40}$$

Since all the n sizes are not statistical independent, from the statistical point of view, the safety threshold α must be replaced with $\overline{\alpha}$;

$$\left(1 - \overline{\alpha}\right)^n = 1 - \alpha \text{, so } \overline{\alpha} = \frac{\alpha}{n} \tag{41}$$

The null hypothesis (H_0):

$$(H_0) : t_j - t_{f,1-\overline{\alpha}} = 0 \tag{42}$$

$t_{f,1-\overline{\alpha}}$ Shall be calculated in accordance with the statistical equations or can be extracted from the Student distribution tables. The decision of the test is the following:

- $t_j \le \mathrm{t}_{\lim} = t_{f,1-\overline{\alpha}} \rightarrow (H_0) : t_j - t_{f,1-\overline{\alpha}} = 0$ is true, so the *j point is not moved* (43)
- $t_j > \mathrm{t}_{\lim} = t_{f,1-\overline{\alpha}} \rightarrow (H_0) : t_j - t_{f,1-\overline{\alpha}} = 0$ is false, an alternative hypothesis is introduced:

$(H_0) : t_j - t_{f,1-\overline{\alpha}} \ne 0$ Therefore the *j point is moved* *(44)*

3.2. The *F* test

The vector of the discrepancies, determined with 30), as shown below:

$$d = \begin{pmatrix} d_{X_1} \\ d_{Y_1} \\ d_{X_2} \\ d_{Y_2} \\ ... \\ d_{X_n} \\ d_{Y_n} \end{pmatrix} \qquad Q_{dd}{}^{+} = \begin{pmatrix} d_{X_1X_1} & d_{X_1Y_1} & & & & & O \\ d_{Y_1X_1} & d_{Y_1Y_1} & & & & & \\ & & d_{X_2X_2} & d_{X_2Y_2} & & & \\ & & d_{Y_2X_2} & d_{Y_2Y_2} & & & \\ & & & & ... & & \\ & & & & & d_{X_nX_n} & d_{X_nY_n} \\ O & & & & & d_{Y_nX_n} & d_{Y_nY_n} \end{pmatrix} \tag{45}$$

We partition a vector: $d_k = \begin{pmatrix} d_{xk} \\ d_{yk} \end{pmatrix} \qquad k = \overline{1,n}$ (46)

$$Q_{dd_K} = \begin{pmatrix} Q_{X_K X_K} & Q_{X_K Y_K} \\ Q_{Y_K X_K} & Q_{Y_K Y_K} \end{pmatrix} \tag{47}$$

For each point, we calculate as shown below, analogous to the Global test of Congruence:

$$F_k = \frac{d_k^{\,T} \cdot Q_{ddk} \cdot d_k}{s_0^{\,2} \cdot h}; k = \overline{1,n} \tag{48}$$

The null hypothesis of the statistical test:

$$(H_0): E\{d_k\} = 0 \tag{49}$$

The value of d_k must be 0. The probability as it follows:

$$P\{F_1 \le F_{\lim} / F_1 \le F_{\lim} / ... / F_n \le F_{\lim} | H_0\} = 1 - \alpha \tag{50}$$

Due to correlating the quantities that were statistical tested, instead of the risk coefficient α , shall be considered

$\bar{\alpha} = \frac{2*\alpha}{u}$; where: u - the number of unknowns *(51)*

$$F_{\lim} = F_{2,f,1-\bar{\alpha}} \tag{52}$$

The decision of the test:

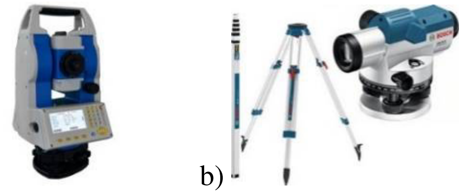
$$F_k \le F_{\lim} = F_{2,f,1-\bar{\alpha}} \rightarrow (H_0): E\{d_k\} = 0 \tag{53}$$

or $F_k > F_{\lim} = F_{2,f,1-\bar{\alpha}} \rightarrow (H_0): E\{d_k\} \ne 0$ *The point k in the network is not moved*

(54)

4. CASE STUDY

Monitoring the stability of the hill's versant at the mining quarry Stoenesti-Plaiul Cheii, located in Stoenești village, in the N-E of Arges county, Romania, using geodetic equipment, Stonex R2+ total station with the accuracy in the determination horizontal angular directions 2", which results in determining distances on the simple prism up to 5000m, 1.5mm+2ppm accuracy; the telescope magnification up to 30X . For monitoring in the vertical plane, Bosch GOL32G Professional optical level was used, with an average standard deviation of 1mm double km in geometric leveling, also with high accuracy for an individual survey by 1mm/30m, with the working range of up to 120m, the minimum focus distance 0.3m and telescope magnification 32X.



a) b)

Figure 1. (a) Stonex R2+Total Station; (b) Bosch GOL32 Professional Optical Level

a) b) c) d)

Figure 2. (a) and (b) 3D tracking points; (c) and (d)Deformations/ effects on Plaiul Cheii hill

After statistical processing the information, resulting in the following data: the planimetric coordinates in Sterographic 1970 coordinates system and elevations in Black Sea 1975 reference system.

Table 1 Summary of coordinates for seven points that were monitored during 2014 and 2015, in 8 stages of measurements

Point no.	N[m]	E[m]	H[m]	Point no.	N[m]	E[m]	H[m]
1I2014	417346,620	512351,006	690,480	1II2014	417346,705	512350,921	690,600
2I2014	417324,335	512291,325	666,220	2II2014	417324,420	512291,240	666,350
3I2014	417304,933	512331,192	680,160	3II2014	417304,935	512331,190	680,160
4I2014	417279,823	512323,138	680,900	4II2014	417279,805	512323,132	680,920
5I2014	417278,544	512364,319	688,660	5II2014	417278,549	512364,318	688,680
6I2014	417265,312	512381,429	693,330	6II2014	417265,581	512381,061	693,470
7I2014	417245,347	512406,275	702,050	7II2014	417245,319	512406,393	702,130
Point no.	N[m]	E[m]	H[m]	Point no.	N[m]	E[m]	H[m]
1I2015	417346,662	512350,964	690,670	1II2015	417346,743	512350,906	690,680
2I2015	417324,543	512291,330	666,520	2II2015	417324,527	512291,385	666,300
3I2015	417304,946	512331,010	680,150	3II2015	417305,124	512330,915	680,170
4I2015	417279,972	512322,925	680,860	4II2015	417280,131	512322,912	680,790
5I2015	417278,818	512364,127	688,510	5II2015	417278,863	512364,001	688,550
6I2015	417265,604	512381,043	693,490	6II2015	417265,542	512381,028	693,460
7I2015	417245,481	512406,349	702,120	7II2015	417245,429	512406,342	702,060

Point no.	N[m]	E[m]	H[m]	Point no.	N[m]	E[m]	H[m]
1III2014	417346,712	512351,080	690,510	1IV2014	417346,762	512351,120	690,560
2III2014	417324,367	512291,279	666,080	2IV2014	417324,407	512291,329	666,110
3III2014	417304,996	512331,054	680,110	3IV2014	417305,016	512331,074	680,130
4III2014	417279,983	512323,025	680,770	4IV2014	417280,003	512323,055	680,790
5III2014	417278,696	512364,099	688,610	5IV2014	417278,716	512364,109	688,660
6III2014	417265,587	512381,053	693,390	6IV2014	417265,597	512381,083	693,440
7III2014	417245,366	512406,430	701,990	7IV2014	417245,366	512406,460	702,030
Point no.	N[m]	E[m]	H[m]	Point no.	N[m]	E[m]	H[m]
1III2015	417346,687	512350,956	690,490	1IV2015	417346,727	512350,996	690,540
2III2015	417324,430	512291,249	666,730	2IV2015	417324,470	512291,279	666,760
3III2015	4173005,034	512330,933	680,180	3IV2015	417305,044	512330,983	680,220
4III2015	417280,098	512322,928	680,790	4IV2015	417280,118	512322,938	680,820
5III2015	417278,869	512363,991	688,560	5IV2015	417278,879	512364,041	688,580
6III2015	417265,589	512380,983	693,420	6IV2015	417265,599	512381,003	693,440
7III2015	417245,375	512406,362	702,090	7IV2015	417245,395	512406,412	702,130

Table 2 Coordinates' variation for seven points that were monitored during the years 2014 and 2015 (right) variation of elevation for point 5 (left)

Point	Quarter I – Quarter II			Quarter II – Quarter III			Quarter III- Quarter IV		
	ΔN	ΔE	ΔH	ΔN	ΔE	ΔH	ΔN	ΔE	ΔH
1	-0,085	0,085	-0,120	-0,007	-0,159	0,090	-0,020	-0,040	-0,030
2	-0,085	0,085	-0,130	0,053	-0,039	0,270	-0,030	-0,050	-0,030
3	-0,002	0,002	0,000	-0,061	0,136	0,050	-0,030	-0,050	-0,050
4	0,018	0,006	-0,020	-0,178	0,107	0,150	-0,010	-0,010	-0,030
5	-0,005	0,001	-0,020	-0,147	0,219	0,070	-0,020	-0,030	-0,020
6	-0,269	0,368	-0,140	-0,006	0,008	0,080	-0,040	-0,040	-0,020
7	0,028	-0,118	-0,080	-0,047	-0,037	0,140	-0,020	-0,010	-0,050
Point	Quarter I – Quarter II			Quarter II – Quarter III			Quarter III- Quarter IV		
	ΔN	ΔE	ΔH	ΔN	ΔE	ΔH	ΔN	ΔE	ΔH
1	-0,081	0,058	-0,010	0,056	-0,050	0,190	-0,040	-0,010	-0,020
2	-0,016	-0,055	0,220	0,097	0,136	-0,430	-0,010	-0,030	-0,050
3	-0,178	0,095	-0,020	0,090	-0,018	-0,010	-0,040	-0,050	-0,010
4	0,159	0,013	0,070	0,033	-0,016	0,000	-0,030	-0,030	-0,020
5	-0,045	0,126	-0,040	-0,006	0,010	-0,010	-0,050	-0,040	-0,020
6	-0,062	0,015	0,030	-0,047	0,045	0,040	-0,020	-0,050	-0,020
7	0,052	0,007	0,060	0,054	-0,020	-0,030	-0,010	-0,030	-0,040

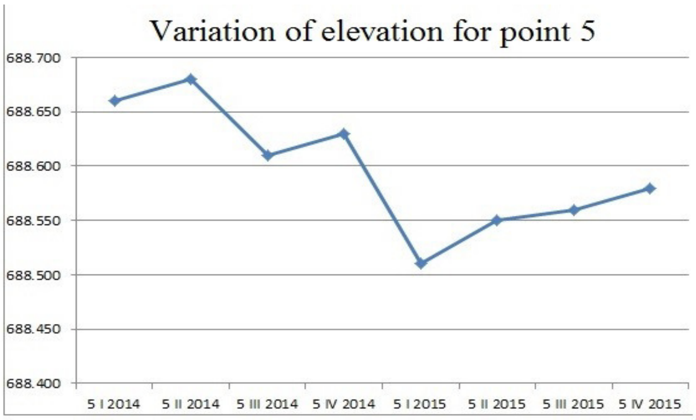


Figure 3.

For the last two stages of the measurements, using the Global Test of Congruence, we determined the size F for planimetry, the practical value of this statistical test, 14.44, which was compared to the theoretical value of the test, $F_{theoretic}$=3.44. The same statistical test was used for leveling, where we determined F=106.20 and $F_{theoretic}$=2.85. For locating deformations we used Student's t-test and the F test, we determined t_{lim}=2.03 and F_{lim}=3.26 for planimetry which we compared with the values we obtained for each point that was monitored, t_j and F_k. For geometric leveling we obtained values t_{lim}=2.63 and F_{lim}=6.94 which were compared to the individual values obtained for each point t_j and F_k.

5. CONCLUSIONS

Using the Global Test of Congruence we highlighted the fact that among the two stages of measurements t_i and t_{i+1} the points are displaced. Using Student's t-test and F-test we conclude that all the analyzed points are displaced, given the fact that the calculated functions are higher than the limit functions for all seven points, $t_j > t_{\mathrm{lim}}$ and, both from planimetric and altitude point of view, this also applies for the last two monitored quarters , III and IV of the year 2015. In Stoenesti mining area we have dealt with macro deformations in the range of centimeter or even decimeter, due to clay extraction activities, however this deformation does not endanger life or people's households, as the mining area is outside Stoenesti village, in an uninhabited area with restricted access. The decision of the Global test of Congruence is true with a statistical probability of 1- α, 1-0,05=0.95=95 %. A decision with statistical probability of 100 % is not possible, this also applies in the case of any statistical test. The Global test of Congruence reveals that the resulting networks in two stages of measurements are not congruent, so there is deformation in the network, but it does not indicate which points are displaced. This statistical test can be used for more than two stages of measurements, in this case, the test function will have a statistical distribution

x^2. Student's t-test is not sufficiently stable, but it is considered stable if the displaced points in the network are not numerous, this conclusion is also valid for the F-test. The test takes into account the coordinates of a point, but it does not take into account the correlations that may arise among points in the network. It is necessary to calculate $\overline{\alpha}$ .This size is not to be found in the Student's distribution tables. Using the F test, we can test every point in the network and also certain groups of points.

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6. REFERENCES

Dima, N., *The theory of errors and the principle of least squares,* Technical University publishing house, Petrosani, (1992).

Dima, N., Herbei, O., Vereş, I., *The theory of errors and the least squares method*, Universitas publishing house, Petrosani, (1999).

Fotescu, N., *The theory of errors and the least squares method*, I.C.B., Bucharest, (1978).

Săvulescu, C., *Processing geodetic measurements-Terrestrial Measurements-Fundamentals-Vol. II* , MatrixRom Publishing House,
Bucharest, (2002).

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Prof. PhD. Eng. Nicolae DIMA

THE MATHEMATICAL ANALYTICAL INTERPRETATION OF THE MEASUREMENTS MADE IN THE SUBSIDENCE MONITORING STATIONS AT LONEA MINE

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RAMONA-RAFILA MARIAN***
DACIAN-ANDREI FLOAREA***

Abstract: *The analysis of surface deformation under the influence of underground mining, is an absolutely necessary operation in order to protect certain goals from surface or from underground. Safety pillars are the only 100% safe method of surface protection, and hence the targets located on it. The other existing methods until now may provide mitigating the negative effects of mining, protecting targets located in the influence area of operation with a certain safety margin. As a result, the correct sizing of the safety pillars is essential, both to protect the objectives and in terms of reducing the losses of useful minerals, avoiding over-sizing them. This requires achieving a more precise prognosis of the subsidence phenomenon parameters.*

Keywords: *surface subsidence, longwall mining, profile function, surveying*

1. GROUND SURFACE DEFORMATION MONITORING AT E. M. LONEA

The phenomenon of surface deformation at E.M. Lonea was notified since 1969 when, in fact, were made the first attempts to establish the parameters of surface deformation [1].

The topographical monitoring station was placed in 1979 with the aim of providing data concerning the parameters of surface deformation in the cover of coal seam no. 3 block VI, as well as of the subsidence limit angle from the roof of the coal seam.

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The topographical monitoring station it's composed by one transversal alignment to the coal seam's direction consisting of the topographical benchmarks no. 30-77 with a total length of 452m. The measurements were made biannually between 1980-1991. In this paper it is presented the analysis of older measurements performed on the transversal alignment by the Department of Mining Topography (University of Petrosani – Romania) and from the research papers carried out by Institute of Research and Mining Design for Coal Petrosani (figure 1) [6], [7].

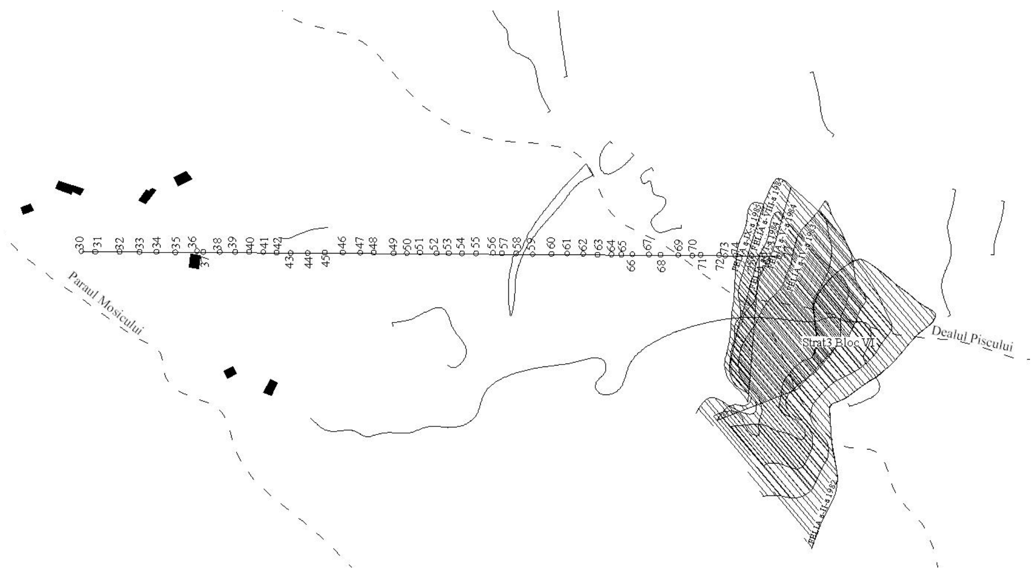


Figure 1. Surface subsidence monitoring station at the Lonea mine (landmarks 30-77)

Coal seam no. 3 (figure 3) block VI shows up like a lenticular shape with a very pronounced variation of its geometrical elements on its direction and tilt. The coal seam has a development his direction of 320m, with a horizontally thickness from 10 to 60m. The seam's tilt it's variable, from 23° to 37° at level 400m and 50° -60° at superior levels.

The mining method applied for coal seam no. 3 block VI is in horizontal slices, with roof control by integral rocks caving.

The maximum measured subsidence in this monitoring station was 19741mm.

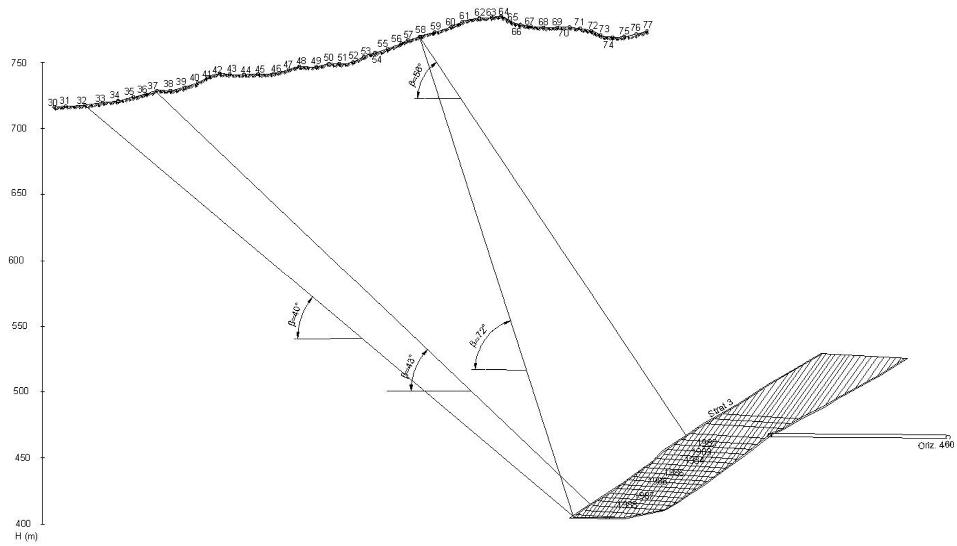


Figure 2. Cross section through the coal deposit, Lonea Mine coal seam no. 3 Block VI

The representation of subsidence curves measured in time on this monitoring station it is presented in figure 3.

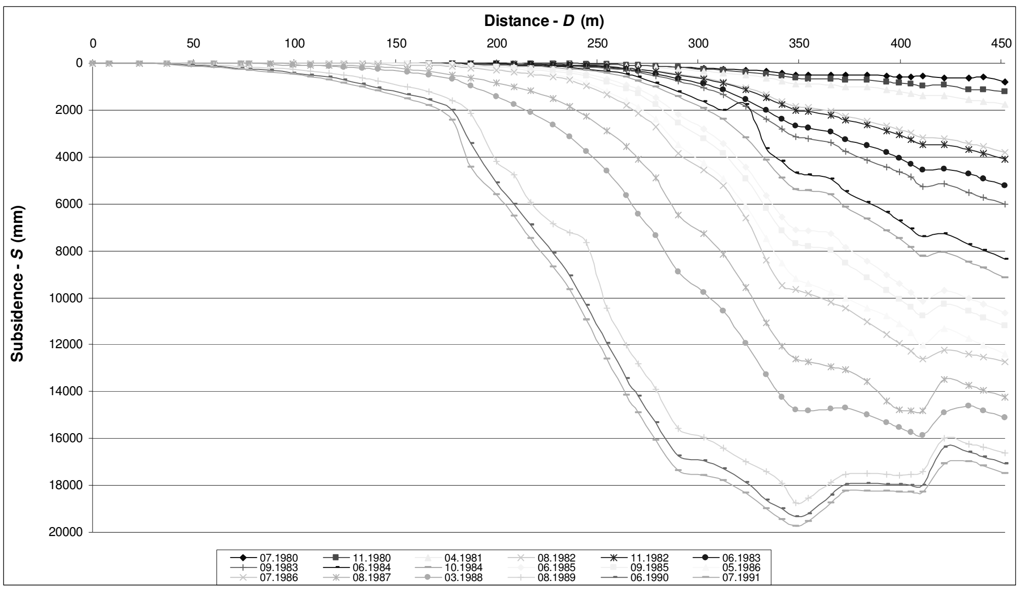


Figure 3. Subsidence curves measured in time at Lonea Mine

2. MATHEMETICAL – ANALITYCAL INTERPRETATION OF MEASUREMENTS

2.1. The profile functions method

The profile functions method tries to define the shape of subsidence trough using a single mathematical equation. In general, they can be applied only in the case of a single extracted space (a single panel), because they fail to recognize how the shape of the subsidence trough is influenced by the adjacent extracted panels. These methods can be easily applied under similar geological and mining conditions, changing only the value of the constants. Some more representative profile functions [2], [3], [4] are presented in Table 1.

Table 1 Profile functions

Function name	Function	Country/place
	Critical extraction	
Hyperbolic	$S(x)=\frac{1}{2}\cdot S_{\max}\cdot\left[1-\tanh\left(\frac{c\cdot x}{B}\right)\right]$	UK
Error	$S(x)=\frac{1}{2}\cdot S_{\max}\cdot\left\{1-\left[\frac{2}{\pi^{1/2}}\int_0^{\ln x/B}\exp\left(-u^2\right)\cdot du\right]\right\}$	Poland/ Upper Silesia
Exponential	$S(x)=S_{\max}\cdot\exp\left[-\left(\frac{1}{2}\right)\cdot\frac{(x+B)^2}{B^2}\right]$	Hungary
	$S(x)=S_{\max}\cdot\exp\left[-\left(\frac{c\cdot x}{B}\right)^d\right]$	SUA/ Appalachia
Trigonometric	$S(x)=\frac{1}{2}\cdot S_{\max}\cdot\left[1-\left(\frac{x}{B}\right)-\left(\frac{1}{\pi}\right)\cdot\sin\left(\frac{\pi\cdot x}{B}\right)\right]$	URSS/Donets
	$S(x)=S_{\max}\cdot\sin^2\left[\left(\frac{\pi}{4}\right)\cdot\left(\frac{x}{B}-1\right)\right]$	Hoffman
	Subcritical extraction	
Trigonometric	$S(x)=S_{\max}(n_1,n_2)^{1/2}\cdot\left[n^2\cdot\left(1-x+\frac{\sin 2\cdot\pi\cdot x}{2\cdot\pi}\right)+\frac{1-n^2}{4}\cdot(1+\cos\pi\cdot x)^2\right]$	URSS/Donets
Hyperbolic	$S(x)=\frac{1}{2}\cdot S_{\max}\cdot\left[\tanh\frac{2\cdot(x+w)}{B}-\tanh\frac{2\cdot x}{B}\right]$	Poland/ Upper Silesia

Where: x is horizontal distance; c – arbitrary constant; B – radius of critical area of excavation; u – integration variable; $S(x)$ – profile function; $S_{\max}$ – maximum possible subsidence; n_1, n_2 – coefficients related to width/depth; n – n_1 or n_2 depending on side of panel.

2.2. Mathematical-analytical interpretation of measurements at Lonea Mine

For the interpretation of the measurements from Lonea Mine was chosen a composed profile function, consisting of a power function and one exponential [2], [3], [4], [5]. The general form of this function is as follow:

$$W(x) = a \cdot x^b \cdot e^{-c \cdot x} \tag{1}$$

Where: *x* is the horizontal distance measured from the limit of subsidence trough; *a*, *b*, *c* – coefficients.

For the statistical approximation of the measurements by means of this profile function, in the first phase were calculated the partial coefficients *a*, *b* and *c* for each partial subsidence trough in part.

The coefficients *a*, *b* and *c* obtained for each partial subsidence trough and the coefficient of determination R^2 for each equation are shown in Table 2.

Table 2 Values of the coefficients *a*, *b*, *c* and the coefficients of determination R^2

Data	**Time *t* [month]**	***a***	***b***	***c***	***R^2***
07.1980	6	0,000034507190	2,7628742040694	0,00000000000006	0,958
11.1980	10	0,000013422990	2,9862803929549	0,00000000000000	0,969
04.1981	15	0,000001535595	3,4006667213604	0,00000000000000	0,974
08.1982	19	0,000022356017	3,0974335745615	0,00000000000000	0,968
11.1982	22	0,000031154942	3,0538815438176	0,00000000000000	0,965
06.1983	29	0,000000330991	3,8616090237818	0,00000000000000	0,979
09.1983	32	0,000000502029	3,8161365571770	0,00000000000000	0,980
06.1984	41	0,000001469876	3,6958456065089	0,00000000000000	0,975
10.1984	45	0,000004316718	3,5345329886313	0,00000000000000	0,975
06.1985	53	0,000027888633	3,2609001179967	0,00001452733202	0,968
09.1985	56	0,000056506736	3,1543870982610	0,00001937642347	0,967
05.1986	64	0,000000050192	4,7146887990465	0,00547779771445	0,974
07.1986	66	0,000000016232	4,9779385342910	0,00644000406121	0,974
08.1987	79	0,000000028784	5,0333054138190	0,00821161756225	0,977
03.1988	86	0,000000005669	5,4971100457001	0,01081126506820	0,984
08.1989	103	0,000000005669	5,4971100457001	0,01081126506820	0,863
06.1990	113	0,000000019243	5,5519892142269	0,01421892696434	0,991
07.1991	126	0,000000022518	5,5386637763603	0,01435946641486	0,993

The subsidence curves measured in time and their statistical approximation is graphically represented in figure 4.

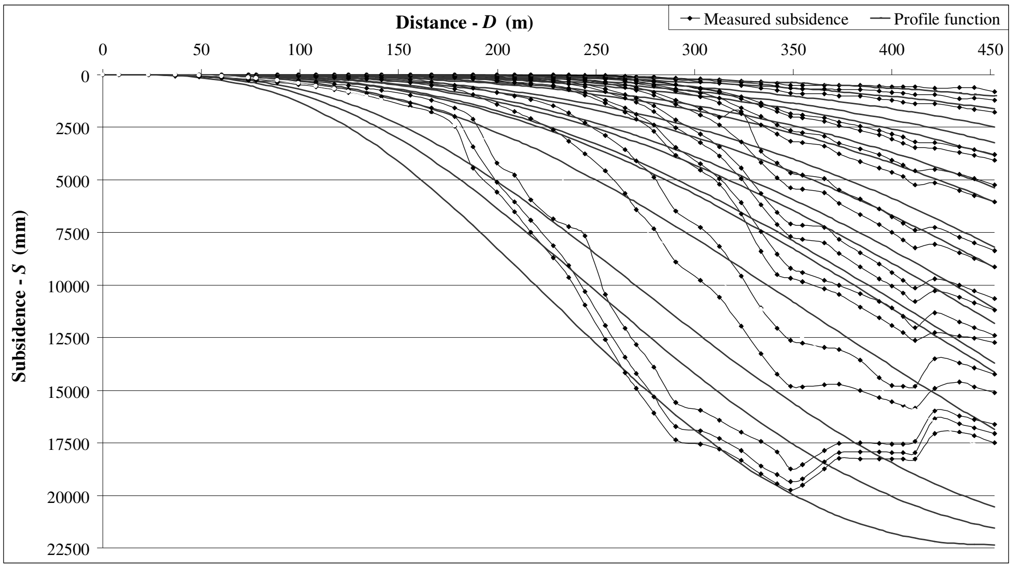
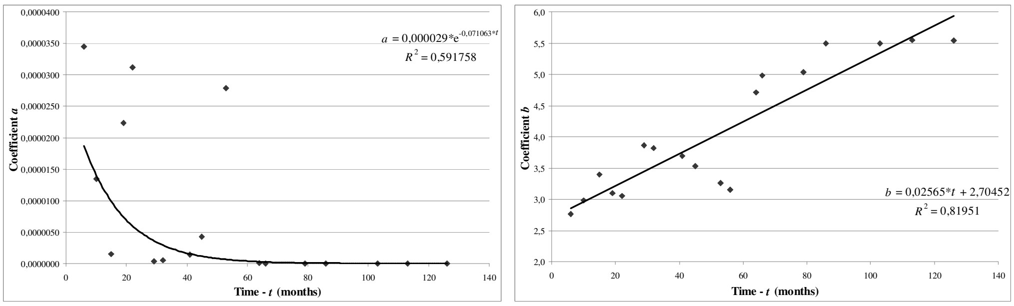
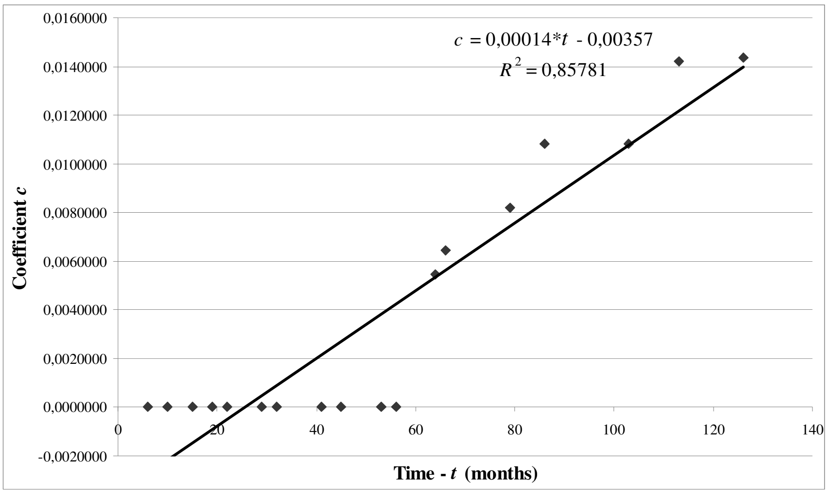


Figure 4. The subsidence curves measured in time at Lonea Mine and their statistical approximation

In this first phase, the profile function depends on a single variable, namely the horizontal distance. In order to introduce the time variable in the profile function, in the second phase, it was made the regression of the all regression coefficients, shown in table 2, depending on the time *t*. The regression of the coefficients *a*, *b* and *c*, depending on time, is graphically represented in figure 5.



a) *b)*



c)

Figure 5. The regression graph of the coefficients *a*, *b*, *c*

The regression of the coefficient *a* has been made by an exponential function, and the coefficients *b* and *c* by a linear function.

The regression of the regression coefficients was performed using the SOLVER module from the EXCEL software. As a result of the regression of these regression coefficients, depending on time, resulted two partial coefficients a_1, a_2; b_1, b_2; c_1, c_2 for each basic coefficient. So, the result is a new generalized profile function, time dependent, which has the following form:

$$S = a_1 \cdot e^{t^{a_2}} \cdot x^{b_1 \cdot t + b_2} \cdot e^{-(c_1 \cdot t + c_2) \cdot x} \tag{2}$$

Where: *x* is the horizontal distance measured from the limit of subsidence trough; *t* – time;

$$a_1 = 0{,}00000001;\ a_2 = 0{,}45699603;$$
$$b_1 = 0{,}0000001;\ b_2 = 3{,}91393195;$$
$$c_1 = 0{,}00006915;\ c_2 = 0{,}00000010.$$

The coefficient of determination R^2, for the final function is: $R^2 = 0{,}960$.

The subsidence curves measured in time and their statistical approximation using the generalized profile function, time dependent, are shown in figure 6.

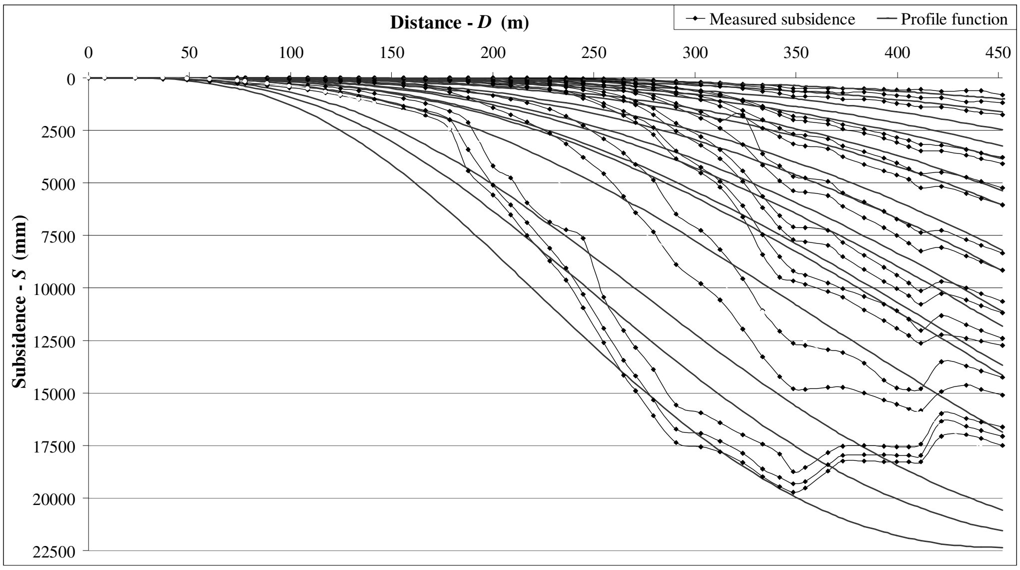


Figure 6. The subsidence curves measured in time at Lonea Mine and their statistical approximation using the generalized profile function

As can be seen from Figure 6, the generalized profile function provides high accuracy in the interpretation of surface subsidence.

If we represent the maximum measured subsidence depending on the time *t* (Figure 7) we can determine the phase in which the subsidence is (the incipient phase, the active phase or the extinguishing phase)

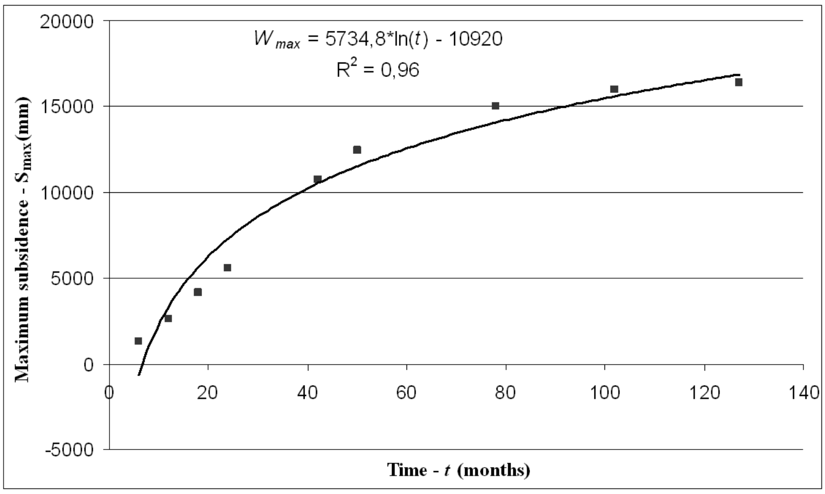


Figure 7. The representation of maximum subsidence in function of time at Lonea Mine

The mathematical law after which the subsidence phenomenon develops at Lonea Mine is:

$$W_{\max} = 5734{,}8 \cdot \ln t - 10920\text{, } R^2\text{=0,98} \qquad (3)$$

Analyzing the graph from figure 6 we can notice that, at the time the monitoring of the surface deformation was no longer achieved at this monitoring station, the subsidence phenomenon in this area was in the phase of extinguishing. In this case, the average speed of subsidence is: $V_i = 129{,}1$ mm/month.

4. CONCLUSIONS

So far, there have been developed numerous prognosis relationships for the calculation of the parameters of deformation and displacement of the surface under the influence of underground mining, relationships that have been developed mainly for horizontal and law tilt deposits. The most used calculation methods for the prognosis are the profile function methods, which attempts to define the form of the subsidence trough using a single mathematical formula.

In general, the profile functions developed until now, both internally and internationally, interpret the subsidence troughs measured in the monitoring stations, depending on the maximum measured subsidence and the horizontal distance. In this paper was presented and applied a time dependent profile function that, as can be seen, provides very good results. Based on this profile function, can be predicted the development in time of the subsidence phenomenon, being able to apply certain measures to protect some objectives from the surface, that will enter in the influence area of the underground mining.

5. REFERENCES

[1]. Floarea, D.A., Marian D.P., Onica, I., Cozma, E. (2015) – *Necessity of Following up the Land Surface Deformation For Closed Mining Areas*, International Multidisciplinary Scientific GeoConference SGEM, Sofia, Bulgaria.

[2]. Marian, D.P. (2011) – *Analiza stabilităţii terenului de la suprafaţă sub influenţa exploatării stratelor de cărbuni cu înclinare mică şi medie din bazinul Văii Jiului*, Teză de doctorat, Universitatea din Petroşani.

[3]. Marian D.P. (2012) – *Urmărirea topografică şi analiza deformării suprafeţei terenului afectat de exploatarea subterană*, Editura Universitas, Petroşani.

[4]. Marian D.P., Onica I., Cozma E. (2011) – New Profile Function for Ground Subsidence Assessment in the Case of Underground Coal Mining, Revista minelor, nr.4.

[5]. Onica, I., Marian, D.P. (2012) - *Ground surface subsidence as effect of underground mining of the thick coal seams in the Jiu Valley Basin*, the Archives of Mining Sciences, Vol. 57, no. 3, p. 547-577; ISSN: 0860-7001.

[6]. Onica, I., Cozma, E., Marian D.P., Ştefan N. (2014) – *Prognosis of the Maximum Subsidence and Displacement of the Ground Surface in the Jiu Valley Coal Basin Conditions*, International Multidisciplinary Scientific GeoConference SGEM, Sofia, Bulgaria.

[7]. Ştefan N. (2015) – *Studiul deformării terenurilor aflate sub influenţa exploatării subterane a stratelor de cărbune din bazinul minier Valea Jiului*, Teză de doctorat, Universitatea din Petroşani.

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Prof. PhD. Eng. Eugen COZMA

THE IMPACT OF HUMAN ACTIVITIES ON THE ENVIRONMENT TO LONEA MINE

MIRCEA GEORGESCU *

Abstract: The whole mining activity from Lonea mine produce because of its specific, multiple and varied environmental impacts. For the quantitative assessment of the impact of activities to Lonea mine, based on values of quality indicators of environmental components analyzed, established in specialized laboratories, two methods were applied to estimate the health of the environment affected by those activities which could be drawn a final and general conclusion that to Lonea the environment, although it is subject to effects of human activities in reasonable limits, can occur the average risks at the level of acceptability and therefore the health of the environment must be constantly monitored.

Key words: Lonea mine, human activities, environment, impact, monitoring

1. THE GENERAL CHARACTERIZATION OF THE AREA ANALYZED

Lonea mining site is located in the Petrila town, in the northeastern part of the mining Jiu Valley basin.

The relief of area which is hosted ore deposit is one plateau with hilly forms in the southern and northeast part, whit terraces along valleys and eastern part is mountainous.

From analyzes all climatic factors result as depression Petrosani, which part area Lonea mine should be considered a topoclimate unit whit winters long without excessive cold, short summers, cool, much fog and hostile, with autumn cold, humid, dark drizzle with frosting and extend from September. Wind regime is characterized by periods of calm (38%) and winds (62%).The days with high cloudiness reach are over 200 annually.

Hydrological network in the Jiu Valley is well represented the two rivers, West Jiu and East Jiu, with numerous affluent. Near locality Lonea flows in East Jiu the most important his affluent Jiet whit 25 km length, forming a narrow valley whit aspect of keys, one advance debit 20.60 m^3/s and incline 13.6 m/km.

Petrosani depression fall underalpine bioclimatic floors (Fsa), the spruce forests mountain (FM3), the mountain mixtures beech whit resinous (FM2) and mountain- piedmont of beech (FM1 + FD4).

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Wild fauna in the area it is recognized on a national and European recognized thanks to the diversity and value of specimens. The associated fauna include species characteristic of coniferous floor of beech (1200 - 1800 m).

In the analyzed area there is a patchwork of soils dominated: brown clay erratic soils; vertisoils (black and brown soils, clay, compact, weak humiferous); regosoils and eroded soils, even surface rock (mostly due to mining); typical alluvial and wash soils.

2. THE IMPACT ON ENVIRONMENTAL COMPONENTS IN MINE FIELD LONEA

2.1. The impact on the air

Coal mining underground and bringing it to the surface is accompanied by large amounts of sediment and particulate matter and gases (CH_4, SO_2, NO_2, CO and CO_2), which pollute the environment, exhausted through the main ventilation stations. Methane and carbon dioxide resulting in a natural way from the ore deposit and other gases from the operating processes unfolded in underground.

Surface activities - sorting, transport, loading, unloading coal and tailings - generate significant amounts of dust suspended, dust settle and sometimes gas. These uncontrolled emissions are dispersed by air currents, in the mine field, but also in neighboring areas (inhabited).

The main sources (stationary and mobile) air pollution generated by mining underground activities at Lonea mine are: the main ventilation station Arsului Valley; the main ventilation station Lonea III Jiet; the thermal station operating on coal; sorting station coal; works of mine; transportation equipment to dump tailings; landscaping dump machines; silt station to prepare pulp ash.

Choice of sampling points for pollutants were made in the vicinity of ventilation shafts at a distance of 100 m and 500 m on the prevailing wind direction. Determinations were performed hourly immissions of NO_x, SO_2, CO resulting from the ventilation stations of Lonea mine. Determination method used (cf. SR ISO ...) was whit electrochemical detectors MSA AUER-type Orion Plus A and B. The average of results analyze, in period 2010-2015, are shown in Table 1.

Table 1. Average concentrations of pollutants SO_2, CO and NO_x from distances to 100m and 500m of ventilation stations Lonea mine in period 2010-2015

Quality indicators	UM/h	Average concentrations determined in period 2010-2015		C_{det} (Accepted values for impact assessment)	MPC (See Law no. 104/15 June 2011)
		distance to 100m	distance to 500m		
NO_x(NO/NO_2)	μg/m^3	762.5	250	506.25	200
SO_2	μg/m^3	662.5	445	553.75	350
CO	mg/m^3	60	14.5	37.25	10

Analysis determined values at three indicators NO_x, SO_2 and CO contained in Table 1, it is noted that both points of determination (100 m and 500 m), on the prevailing wind direction, were exceeded maximum concentration values permissible, in accordance with the air quality Law 104/2011 for indicators NO_x, SO_2, and CO.

In addition to these gases exists and the concentrations of suspended particulates discharged into the environment resulting from the activities on the surface of the Lonea mine (e.g. central heating), which exceed the maximum permissible concentration.

These particulate matter represents a complex of solids very small composed of a variety of substances including sulphates, nitrates, ammonia, sodium chloride, carbon dioxide and dust mineral spirits. Depending on the size of the particles which make up the associations are distinguished PM_{10} large or "coarse" - have a diameter of less than 10pm, fine - with a smaller diameter 2.5pm ($PM_{2.5}$) and less fusing- are particles smaller than 0.1pm ($PM_{0.1}$).

For PM_{10} daily limit value is 50µ mg/m^3 and the annual 20µ g/m^3. $PM_{2.5}$ standards were established by WHO in 2005 to limit values of 25µ g/m^3 for 24 hours to 10 µ g/m^3 annual mean limit. Daily limit value of 25 mg/m^3 entered into force on 1 January 2010 as the target and become mandatory in 2015 legally.

2.2. The impact on the waters

Waste waters from as a result of the work at Lonea mine are mine waters and household waste waters

Mine waters are waters from opening, preparatory driving and exploitation works and of technological processes to filling-silting, spraying, which is collected in storage tanks of pump stations through channels or pipes. The waters are discharged from the main pump station for waste water disposal from hor. 400m, to the surface through two discharge pipes mounted auxiliary shaft Lonea II where the treatment plant is treated mine water, then discharged into the creek Arsului Valley.

Household waste (sewage) waters are collected at the surface and directive through piped to the sewage treatment plant and then discharged into the creek Arsului Valley.

For determining the quality of waste water from Lonea mine were summarized and analyzed data obtained from laboratory analysis (after SR ISO SR EN, STAS) both sewage and mine water, after their removal from treatment plants where are discharged directly into the creek Arsului Valley, for a period of six years (2010-2015).

From the multitude of data provided by SDM Petrosani and SH Petrosani, obtained by collecting monthly samples was performed statistical processing concentration values of quality indicators, imposed by NTPA-001/2002 amended in 2007, so that the table 2 presents statistical averages of these concentrations. It is found that the concentrations of indicators of water quality, after leaving the treatment plants, most of them are below the maximum permissible concentration (MPC), it was normal, but there are exceptions (suspensions, ammonium, BOD_5, COD- Cr), where the average exceeds the MPC. This should stand the attention of those who have responsibilities in this sector.

Table 2. Average concentrations of quality indicators determined at the outlet of the treatment plant, 2010-2015

No. crt.	Quality indicators	UM	Average concentrations determined (C_{det}) *at the outlet* of the treatment plant, during 2010-2015		MPC acc. NTPA-001/2002 Change 19.03.2007
			Sewage waters	Mine waters	
1.	pH	units pH	6.86	7.32	6.5-8.5
2.	Fixed residue	mg/dm^3	320	1503	2000
3.	Suspensions		16.08	69.23	35
4.	Ammonium		12.06	-	2
5.	BOD_5		23.03	-	25
6.	COD-Cr		94.08	124.48	125
7.	Sulphate		29.65	71.67	600
8.	Total phosphorus		0.08	-	1
9.	Chlorides		37.11	514.06	500
10.	Nitrates		20	-	25
11.	Detergents		0.03	-	0.5
12.	Nitrites		0.04	-	1
13.	Iron		-	0.13	5
14.	Calcium		-	91.25	300
15.	Magnesium, Mg^{+2}		-	7.59	100.6
16.	Phenols		-	0.15	0.3

2.3. The impact on the soil

The total area of land occupied by Lonea mine, for mining, is $376134m^2 \cong 38ha \cong 0.38km^2$.

In terms of safety pillars, the analysis performed, it was found necessary to protect an area of $211.855\ ha \cong 2.12km^2$, and surface affected by coal mining (01.01.2015) is 214.1 ha. This area refers to all the land where they have been manifested phenomena of dislocation/deformation as a result of mining activities, starting line outcrop (including former open pit Defor). The only land subsidence monitored in present is arranged along the creek and street Defor above the stops 34-37. Surface mining area Lonea recalculated in coordinates STEREO 70 is *1506.7 ha* and the total area within the logging is *464.4ha* ($4.65km^2$).

From the chemical analyzes of soil made by the CNH Petrosani in the period 2010-2015 have been select a few indicators of quality whose concentrations exceed the maximum permissible (MPC).

Table 3. Average concentrations of soil quality indicators in 2010-2015

No. crt.	Quality indicators	UM	Average concentrations (C_{det}) 2010-2015	MPC Acc.Ordin no. 756/1997
1.	Barium (Ba)	mg/kg dry substance	501	200
2.	Manganese (Mn)		330	900
3.	Chromium (Cr^{+3})		186	30
4.	Nickel (Ni)		88	20
5.	Zinc (Zn)		63	100
6.	Copper (Cu)		50	20
7.	Vanadium (V)		102	50
8.	Arsenic (As)		5	5
9.	Lead (Pb)		40	20
10.	Cobalt (Co)		13	15

2.4. The impact caused by noise

At Lonea mine sources on the surface, which produce noise in the environment, are: means of transport auto, the station fans, the station of compressors, the metal manufacturing workshop, the mechanical workshop.

To determine the impact of noise from these sources were performed periodic measurements of *integrated sound level - equivalent continuous level (Leq)*, with the sonometer, according to specific standards. Analysis points were: main mine yard, at 2m from station fans Jieţ, at 4m from mechanical workshop, at 4m compressor station, at main yard limit Lonea - Jieţ, in vicinity and inside of private housing (Table 4).

Table 4. Noise level, *Leq*, produced by the activities of the surface to Lonea mine

No. crt.	Point analysis	U.M.	Averages value *Leq* in period 2012-2015	Allowable limit *Leq* (Law no. 84/2006)
1.	Main mine yard	dB(A)	53.7	55
2.	Station fans – Jieţ (at 2m)		64.8	60
3.	Compressor station (at 4m)		65.1	60
4.	Mechanical workshop (at 4m)		58.3	60
5.	Metal manufacturing workshop		58.1	60
6.	Gate private housing (at 1m)		50.2	60
7.	Interior courtyard (at 3m of house)		45.6	55
8.	Private housing (at 1m of house)		48.7	55
9.	Interior private housing		43.3	35

3. ASSESSMENT OF THE IMPACT OF POLLUTION AT LONEA MINE

3.1. Matrix assessment of the impact of pollution

To emphasize that of the components of the environment will be most severely affected by an activity can apply *RIAM method (Rapid Impact Assessment Matrix)*. It is based on a standard definition of important criteria for evaluating and means by which it can be deduced quasi-quantitative values for each of these criteria (represented by a concrete note, independent) (table 5).

RIAM calculation procedure involves the following equations:

$$A_1\ A_2 = A_t$$
$$B_1 + B_2 + B_3 = B_t \qquad (1)$$
$$A_t\ B_t = SE$$

where: A_1, A_2, B_1, B_2, B_3 - evaluation criteria by the method RIAM
A_t, B_t - notes obtained by multiplying, respectively, addition values of evaluation criteria
SE - scoring of environment for the analyzed components.

Table 5. Criteria and evaluation steps whit RIAM method

Criterion	Scale	Descrption
A1 The importance of the environment change (of effect)	4 3 2 1 0	Important to the interests of national / international Important for the interests of regional / national Important and the areas around the site area Only important for local conditions Without importance
A2 The magnitude of the environment change	+ 3 + 2 + 1 0 - 1 - 2 - 3	Important major benefit Significant improvement from the status quo Current improve Unchanging current state Negative change from the status quo Significant disadvantages or negative changes Major disadvantages or negative changes
B1 Permanence	1 2 3	Without changes Temporary Permanent
B2 Reversibility	1 2 3	Without changes Reversible Irreversible
B3 Cumulativitate	1 2 3	Without changes Uncumulative / single Cumulative / synergistic

After obtaining the average scores, they are converted into *categories of impact (CI)* on the basis of the scale conversion in table 6.

Table 6. Convert scores environmental impact categories

Score of environment (SE)	Categories (Code)	Description of category of impact (CI)
+ 72 → + 108	+ E	Major positive impact
+ 36 → + 71	+ D	Significant positive impact
+ 19 → + 35	+ C	Moderate positive impact
+ 10 → + 18	+ B	Positive impact
+ 1 → + 9	+ A	Impact slightly positive
0	N	Lack of change / a status quo / Not applicable
- 1 → - 9	- A	Impact slightly negative
- 10 → - 18	- B	Negative impact
- 19 → - 35	- C	Moderate negative impact
- 36 → - 71	- D	Significant negative impact
- 72 → - 108	- E	Major negative impact

For Lonea mine the evaluation by RIAM method is shown in table 7 on the basis of criteria and mode conversion shown in tables 5 and 6.

Table 7. The assessment with RIAM method

Environmental component	Evaluation criteria					Score of environ-ment (SE)	Category impact, (CI)	
	A_1	A_2	B_1	B_2	B_3		Code	Description
Air	2	-1	3	3	3	-18	-B	*Negative impact*
Mine waters	2	-1	3	3	2	-16	-B	*Negative impact*
Sewage waters	2	-1	3	3	2	-16	-B	*Negative impact*
Soil	1	-2	2	2	2	-12	-B	*Negative impact*
Noise	1	-1	2	3	3	-8	-A	*Slightly negative impact*

3.2. Integrated assessment of the impact and risk of pollution

Environmental impact and risk assessment is an important tool for decision-making and involves in particular the collection of data about the quality of the environment in general and about the quality of environmental components (air, water, soil etc.) in particular. To do this, in the previous paragraphs were presented analyzes of environmental components (air, water, soil) could be affected by mining activities of ground of Lonea mine, but also outside it.

The Environmental Evaluation System includes estimating and quantifying environmental impacts assessed in terms of measurable units as *importance units* (UI). The scores environmental impact assessments granted environmental impact are based on two components: *magnitude* of environmental impacts and *importance*.

Assessed environmental component quality (Q) is determined as the ratio of maximum permissible concentration (MPC), as required by law, and determined concentration in the environment (C_{det}) at a time for a particular pollutant.

$$Q = MPC / C_{det} \tag{2}$$

In a first stage established environmental components considered in the impact assessment and risk. For Lonea mine: air, water (mine and sewage), soil and noise.

The degree of importance of each component of the environment taken into account, on a scale from 0 to 1, where 1 is the value of the highest importance, is assigned to C_{det} in relation to the MPC.

In order to reduce the degree of subjectivity in the calculation of units one uses matrix calculation method, obtaining *normalized scores* (SN), first, and then the *units of importance* (UI) for each environmental component.

*The magnitude of environmental impacts (*MI*)* is:

$$MI = Q \cdot UI \tag{3}$$

The environmental risk (RE) is calculated with relation:

$$RE = MI \cdot P \tag{4}$$

where: P- the probability that the impact to occur over a environmental component (table 8).

Table 8. The probability of impacts on the environmental components

The environmental component	**Probability impact**	**Unit probability, P**
Air	Almost certainly happens in 90% of cases	0.9
Mine waters *)	Almost certainly happens in 90% of cases	0,8
Sewage waters *)	Almost certainly happens in 90% of cases	0,8
Soil	Certainly be achieved in 99% of cases	1,0
Noise	Almost certainly happens in 90% of cases	0.9

*) Out of sewage stations

For the Lonea mine settled the degrees of importance to environmental components as they are rendered in table 9, depending on which units were calculated importance (see table 10).

Table 9. The calculation of the sum of importance for each component

The environ-mental component	The degree of importance	Importance of environmental components in relation to other environmental components					Sum of Importance SI
		Air	Mine waters *)	Sewage waters *)	Soil	Noise	
Air	1,00	1,00	1,11	1,11	1,11	1,25	5,58
Mine waters *)	0,9	0,9	1,00	1,00	1,00	1,12	5,02
Sewage waters *)	0,9	0,9	1,00	1,00	1,00	1,12	5,02
Soil	0,9	0,90	1,00	1,00	1,00	1,12	5,02
Noise	0,8	0,80	0,89	0,89	0,89	1,00	4,47

*) Out of sewage stations

Table 10. Calculation units of importance

The environmental component	Normalized scores SN=1/SI	Units importance UI=SNx1000
Air	0,179	179
Sewage waters *)	0,199	199
Sewage waters *)	0,199	199
Soil	0,199	199
Noise	0,224	224
Total	1,000	1000

Table 11 presents the calculation of environmental impacts based on quality indicators established for each environmental component analyzed and environmental risks associated with each impact by taking the unit values the importance and probability in tables 8 and 10.

Table 11. The calculation of environmental impact and risk at Lonea mine

The environ-mental component	Quality indicator	MPC	C_{det}	Q	UI	MI	P	RE
Air	$NO_x(NO/NO_2)$	200	506,25	0,40	179	78	0,9	70
	SO_2	350	553,75	0,63				
	CO	10	37,25	0,27				
	Impact and environmental risk Σ/n			0,43				
Mine waters	pH	6,5	7,32	0,89	199	652	0,8	522
	Fixed residue	2000	1503	1,33				
	Suspensions	35	69,23	0,51				
	COD-Cr	125	124,48	1,01				
	Sulfate	600	71,67	8,37				
	Chlorides	500	514,06	0,97				
	Calcium	300	91,25	3,29				
	Magnesium	100,6	7,59	13,25				
	Phenols	0,3	0,15	2,00				
	Impact and environmental risk Σ/n			3,28				
Sewage waters	pH	6,5	6,86	0,95	199	1567	0,8	1253
	Fixed residue	2000	320	6,25				
	Suspensions	35	16,08	2,18				
	Ammonium	2	12,06	0,17				
	BOD_5	25	23,03	1,09				
	COD-Cr	125	94,08	1,33				
	Sulfate	600	29,65	20,24				
	Total phosphorus	1	0,08	12,50				
	Chlorides	500	37,11	13,47				
	Nitrates	25	20	1,25				
	Detergents	0,5	0,03	16,67				
	Nitrites	1	0,04	25,00				
	Impact and environmental risk Σ/n			7.87				
Soil	Barium (Ba)	200	501	0,40	199	131	1,0	131
	Chromium (Cr^{+3})	30	186	0,16				
	Nickel (Ni)	20	88	0,23				
	Zinc (Zn)	100	63	1,59				
	Copper (Cu)	20	50	0,40				
	Vanadium (V)	50	102	0,49				
	Arsenic (As)	5	5	1,00				
	Lead (Pb)	20	40	0,50				
	Cobalt (Co)	15	13	1,15				
	Impact and environmental risk Σ/n			0,66				

Noise	Main mine yard	55	53,7	1,02	224	231	0,9	208
	Station fans – Jieţ (at 2m)	60	64,8	0,93				
	Compressor station (at 4m)	60	65,1	0,92				
	Mechanical workshop (at 4m)	60	58,3	1,03				
	Metal manufacturing workshop	60	58,1	1,03				
	Gate private housing (at 1m)	60	50,2	1,20				
	Interior courtyard (at 3m of house)	55	45,6	1,21				
	Private housing (at 1m of house)	55	48,7	1,13				
	Interior private housing	35	43,3	0,81				
	Impact and environmental risk Σ/n			1,03				

The classification of impact and risk environmental is presented in table 12.

Table 12. Classification of impact and risk environmental

Environmental impact	Description	Environmental risk	Description
<100	degraded environment, improper forms of life	<200	major risk, are necessary prevention measures
100-250	environment severely affected by human activities		
250-350	environment effected of human activities causing disturbances life forms	200-350	medium risk, are necessary prevention measures
350-500	environment effected of human activities causing states of discomfort	350-700	medium risks to an acceptable level, should be monitored
500-1000	environment effected of human activities to reasonable limits	700-1000	allowable limits of human minor risks, but should be considered/ monitored
>1000	environment unaffected by human activities/natural quality	>1000	negligible risk, insignificant

Given the classification of table 12 the following conclusions on the impact and risk activities at Lonea mine:

- from the point of view of environmental *component of air, degraded environment, improper forms of life, with major risks, preventive measures are needed*;

- from the point of view of environmental *component mine waters, environmental effects of human activities subject to reasonable limits, with medium risk to an acceptable level should be monitored;*

- from the point of view of environmental *component of sewage waters, environment unaffected by human activities/natural quality, risks negligible/insignificant*;

- from the point of view of environmental *component of soil, environment severely affected by human activities, major risks, preventive measures are needed*;

- from the point of view of environmental *component noise, environment severely affected by human activities, medium risks, preventive measures are needed.*

Calculating averages for the five environmental components analyzed, is obtained a medium environmental impact MI = 532 and a medium risk RE = 437, which qualifies for the area afferent of Lonea mine as an environment with effects of human activities within acceptable limits, with an medium risks to an acceptable level, should be monitored.

4. CONCLUSIONS

The entire mining activity from Lonea mine produce because of its specific, multiple and varied adverse effects on the environment, namely:

- *occupation of land areas* for activity in surface mine, dump, coal storage, workshops, social and administrative block, access roads etc., surfaces which are thus totally unusable for other purposes for a long time, whit effects on local communities;

- *land degradation,* through vertical and horizontal movements of the surface (subsidence) and possible landslides of dumps, with heaps of causing accidents;

- *surface water pollution* (especially the creek Arsului Valley) by sometimes careless discharge of water from sewage station;

- *negative influences on the atmosphere, flora and fauna* by issuing polluted air to the surface from underground by fans stations and by the heating station;

- *chemical pollution of the soil*, which can affect for many years its fertile;

- *noise and vibration* spread by equipment from yard mine,on the environment, with a strong adverse action.

For the quantitative assessment of the impact of activities to Lonea mine values were used as indicators of the five components analyzed environmental (air, mine waters, sewage waters, soil and noise) established laboratories of SDM Petrosani, SH Petrosani, Petrosani INSEMEX and University of Petrosani in the period 2010-2015 (published values).

In this paper, two methods were applied to estimate the health of the environment affected by these activities, namely:

• *Method RIAM (Rapid Impact Assessment Matrix)*, which qualifies the environment of analyzed area as one submissive impacted negatively;

• *Method integrated assessment of the impact and risks of pollution*, which qualifies for the Lonea mine as an environment submissive effects of human activities within acceptable limits, with average risk to an acceptable level should be monitored.

Comparing results from the methods mentioned above can draw a final and general conclusion that the environment of Lonea mine, it is in reasonable limits, can occur at average risk acceptability and therefore the health of the environment should be permanent monitored.

Therefore it is considered that the *Conformance Program* which is part of the *Environmental permit* no. HD 28/01.31.2013, outside the planned work: heaps slopes stabilization, land leveling and cleaning drainage channels from the dumps to provide and other works such as:

- avoiding the filing uncontrolled of tailings in dumps;
- execution of consolidation works for fixing dumps in areas in an uncertain state of stability;
- for all dumps the final solution must be reconstruction (repopulation vegetable or other uses);
- permanent monitoring of surface areas under the influence of underground mining (subsidence areas), taking appropriate measures to avoid human and animals accidents;
- upgrading the efficiency of purification existing stations because were found in excess of pollutants exceeding maximum permissible concentrations;
- setting of effective filters for dust retention and neutralization of pollutants emitted by fans and heating stations;
- executing of guard channels on the contour of the cones and riverbeds of crumbling, to reduce the quantity of storm water.

Lonea mine will need to implement an effective system of continuous monitoring of the environmental components according to the Mining Industry Strategy for the period 2012-2035.

REFERENCES

[1]. **Georgescu, M**., *Managementul riscurilor de mediu*, *curs online*, Petrosani, 2015.

[2]. **Onica, I. a.o.,** *Studiul de fezabilitate pentru E.M. Lonea,* Universitatea din Petrosani, 2015

[3]. **Robu Brânduşa**, *Integrated impact and risk assessment induced in the environment by industrial activities,* Ecozone Press, Iaşi, 2005

[4]. **x x x** *Strategia industriei miniere pentru perioada 2012-2035*, 2012.

[5]. **x x x,** http://www.calitateaer.ro

[6]. **x x x**, http://www.jiuvalley.com

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THE IMPACT ON RESIDENTS HEALTH NEAR THE COAL DEPOSIT OF ROŞIUŢA COAL PIT

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CIPRIAN NIMARĂ **

Abstract: All mining activity occurs due to its specific, multiple and varied adverse effects on the environment and consequently on population, as exemplified by: changes in the landscape, occupying large areas of land for operating activities, stockpiles, storage minerals, industrial plants, roadways etc., land degradation, watershed polluted surface and groundwater, the groundwater hydrodynamic imbalance, negative influences on the atmosphere, flora and fauna, soil chemical pollution, noise, vibration and radiation spread into the environment, with a strong adverse action. Roşiuţa coal pit is part of the Motru coal pits whose activity performed within the current lignite coal pit and has a capacity of about 3 million tons per year.

Key words: coal pit, health safety, environmental risk, Rosiuta coal pit, Romania

1. Geographical location, history and overview of the activities in the coal pit area

Motru municipality is located on Route 67A, 44 km from the city of Tg. Jiu and 42 km from Dr. Tr. Severin, being the second city of size and importance of Gorj county, after Tg. Jiu. It is located at the southern limit of county. City area is 50.09 km^2. The number of resident population of the municipality and villages belonging to Motru is 22 295 inhabitants. Motru city population number is: 18 309. The population from the villages is shown in table 1:

Table 1. **Population in the enclosed villages**

Locality	Inhabitants	Locality	Inhabitants	Locality	Inhabitants
Ploştina	1160	Dealul Pomilor	289	Leurda	243
Roşiuţa	746	Lupoiţa	81	Râpa	402
Horăşti	536	Însurăţei	529		

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Roşiuţa coal pit is part of Motru Mining Exploitation of coal pits subunit of Oltenia Energy Complex SA, located in the north-west of Oltenia (Oltenia coalfield) and in the south-western county of Gorj, in the north - east of the Motru mining basin on the administrative are of Motru municipality, Roşiuţa village and administrative territories of Ciuperceni, Mătăsari and Slivileşti municipalities (figure 1).

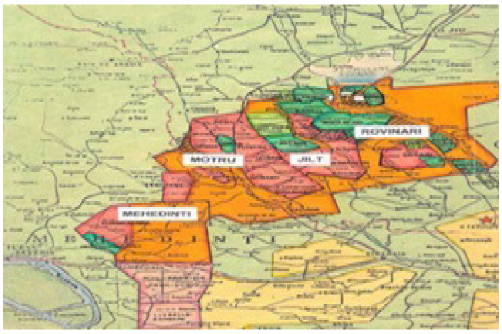

Fig.1. Geographical location

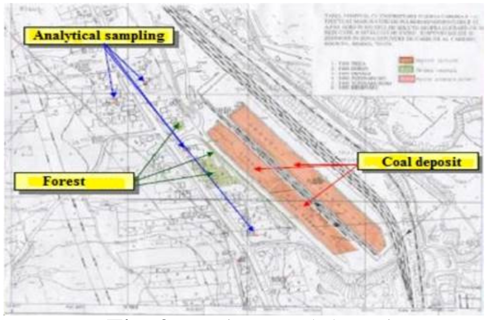

Fig. 2. Roşiuta coal deposit

Placement of Roşiuta coal pit was determined by the existence of large reserves of lignite, with exploitative workings to date [5]. Roşiuţa coal pit was put into operation in 1969, when the work began with underground mining at a capacity of 1,000 tons/year. In 1980 the stripping work began to open small coal pits works that have continued in the period of 1981-1985. From 1985 until now, the work was carried out in the current lignite pits, with an operating capacity of 3 million tons per year. The exploitation method is to transport the sterile to inner dumps part (Roşiuţa) and partly to external dumps (Bujorăscu Mic Ştiucani, Rogoaza). The occupied area is 571 hectares and the calculated reserves until 2020; future development of the business until 2020 has considered the request of lignite domestic assessing the needs of the same traditional customer - Işalniţa power plants and Craiova South, but other secondary possible beneficiaries are CET Oradea, CET Suceava etc. and population.

The coal deposit, which serves the coal pit, is located in its perimeter, in Roşiuţa, near the DN 67 national road that connects the towns Tg. Jiu - Motru - Drobeta Turnu Severin (figure 2).

2. Characterization of population exposure to dangerous substances and dangerous situations

The sulfur dioxide. Adverse effects associated with exposure to elevated concentrations of SO_2 include breathing problems, impaired pulmonary defense mechanisms and worsening cardiovascular disease. Children, the elderly, people with asthma and people with cardiovascular disease or chronic lung disease (chronic bronchitis, emphysema) are the populations most susceptible to adverse health effects associated with exposure to SO_2. Odor threshold is around 0.5 ppm and 6-10 ppm and cause eye irritation, nose and pharynx. SO_2 can cause chronic obstructive pulmonary disease in terms of exposure to high doses. SO_2 causes exacerbations of asthma in individuals with the disease at levels of 0.25 ppm [6].

Nitrogen oxides are absorbed so large airways and small airways. Very high concentrations (> 200 ppm) are very dangerous determining lung damage, pulmonary edema and bronchopneumonia. Lower concentrations affects mucociliary clearance, transport particle, the function of macrophages and local immunity. Headache and respiratory symptoms were reported especially those with preexisting lung disease. In human subjects, exposure to high levels (2-5 ppm) 3:00 causes inflammation in the airways and increased serum IgE-specific antibodies, IgA, IgG and IgE locally. Moderate exposure to NOx 260 ppb (0.260 ppm or 0.490 mg / m3) for 30 minutes non-specific reactivity increases and in 6.6% of cases decreased PEFR in the last phase of the asthmatic reaction to antigen. About 80 ppb levels were associated with a significant increase in acute respiratory infections, angina, common colds and truancy.

Low concentrations of **hydrogen sulphide** is not harmful, but shows an odor. The odor threshold is 1-45 mg/m^3 for people sensitive and higher for those exposed repeatedly. At low concentrations, hydrogen sulfide is oxidized blood passes sulphides and does not accumulate in the body. However, citing the occurrence of liver and kidney in individuals chronically exposed. Can produce effects include ocular conjunctivitis, diseases irreversible eyeball, which is associated with an exposure of 20 ppm. Brief exposure to H_2S, between the limits of 5 to 15 ppm can cause eye irritation, common effects to human and animals [4].

Methane. Basically methane is not a toxic substance that produces adverse effects on the health of the population. There is a study that shows that exposure of human erythrocytes methane and nitrogen can produce their hemolysis. Ruminant methane can produce effects on fatty acids. Methane can cause central nervous system depression on hypoxia (in terms of massive exposure deliberate and/or accidental), and rarely cardiac excitability disorders. Methane combustion can release carbon monoxide (especially under conditions of incomplete combustion) that can be dangerous to health, in spacious dark and stuffy [7].

Polycyclic aromatic hydrocarbons (PAHs) are a group of chemicals resulting from incomplete combustion processes of coal, oil, gas, wood, organic waste, tobacco and even meat. There are over 100 different PAHs. Solids are colorless, white or yellow-green, average spread in the air, water and soil. Air attaches to the surface of the particles in suspension. They are poorly soluble in water. A total of 17 PAHs are suspected to have adverse effects on health, of which the best known are: acenaphthen, anaceftilen, anthracene, benzantracen, benzopyrene, benzapiren, benzofluoranten, benzoperilen, crizen, dibenzantracen, fluoranthene, fluorene, indenopiren, phenanthrene and pyrene. The most common sources of exposure are inhalation of cigarette smoke, auto exhaust, fumes from burning coal, wood or organic waste from agriculture. The average levels of the atmosphere are estimated around values of 0.02-1.2 ng/m^3 in rural areas and 0.15-19.3 ng/m^3 in urban areas [1, 2].

Noise. Overall noise with its stimulatory effects, indifferent or inhibitors represent a natural component of the environment. Its absence cause an artificial atmosphere of quiet, hard bearable, thanks to a so-called "assault of silence" that under certain conditions of prolonged and repeated exposure manifests its harmful influence on the entire body, especially on organ specific receptor. Average values of noise levels produced by indoor sources are shown in Table 2:

Table 2. **The level of noise produced by main inside sources**

Noise source	Noise level (dB)
Whispered conversation	20-30
Alarm clock	30
Refrigerator	45
Hairdryer	50
Conversation	40-60
Vacuum cleaner	70
Ringing phone	70-75
Door bangigng	80
Radio, television	80-85
Child cry	85

The effects of low levels of noise on the body are shown in the table 3:

Table 3. **Effects of low levels of noise on the body**

Equivalent noise level/ features dB (A)	Effect
20-45	Reducing speech intelligibility
>35	Affecting the sleep
Repeated intermittent or persistent noise	Definitive alteration of neurovegetative system
	Circulatory disorders
	Digestive disorders
	Endocrine disorders

3. Measurements carried out in authorized laboratories approved by the legislation for the area to be analyzed - homes near Roşiuţa coal deposit

Total suspended particulates - sediment particles. The concentration of emission pollutants in ambient air can vary depending on weather conditions more or less favorable to a good dispersion. According to the environmental authorization number 20 of 19 February 2009 were imposed as conditions:

a) Monitoring of sedimentary powders to monthly limit of functional area locations; the following families: Manescu G., Popescu I., Tutunaru I., Brebinaru Maria, Tutunaru P., Jilavu Ctin, Mihai M.;

b) Monitoring of suspended particles, indicatives measures for the locations; the following families: Manescu G., Popescu I., Brebinaru Maria, Mihai M., Jilavu Ctin;

c) Noise monitoring - determination to the limit area of influence due to the equipment operation and installations in the vicinity of residential areas, for locations: Mănescu G., Popescu I., Brebinaru Maria, Mihai M., Jilavu Ctin.

The monitoring network of air quality in the analysis area for TSP pollutant (total suspended particulates) included in the range from March to August of 2015, 7-point sampling, samples arranged in 7 dwellings (measurements required by the environmental permit No. 20/19.02.2009) of Roşia namely: home of Jilavu, Brebinaru, Carlaont, Mănescu, Mihai Vasilescu and inhabited area of town Lupoaia (neighboring village Rosia). Synthesizing the results appear in Table 4.

Table 4. **Synthesizing the results**

No.	**Sampling point**	**Month. Year 2015**	**Average concentration of suspended particulates [mg/m^3] determined by short time sampling (30 min)**	**M.A.Q mg/mc STAS 12574/87**	**Exceeding the maximum admitted concentration**
1	Jilavu residence	march-nov.	0,029	0,50	-
2	Brebinaru residence	march-nov.	0,068	0,50	-
3	Carlaont residence	march-nov.	0,064	0,50	-
4	Manescu residence	march-nov.	0,11	0,50	-
5	Mihai residence	march-nov.	0,076	0,50	-
6	Vasilescu residence	march-nov.	0,091	0,50	-
7	Lupoaia residence area	march-nov.	0,029	0,50	-

Regarding the **particulate sediment**, the monitoring network of air quality in the analyzed area for sediment particles pollutant comprised between January-October of 2015, eight sampling points with samples arranged in 7 residences of Rosia (village neighboring Roşiuţa village,table 5).

It follows from that the sedimentary powders are found exceeding the allowable admitted concentration compared to 1.1 - 1.7 times (Eg. 17g / m^2 / month - cf. STAS 12574/1987), charging the atmosphere are due to activities in the coal depot career but heavy traffic due to the increasing number of vehicles and the fact that the deposit is located near national road DN67. From previous studies, the studied risk conducted by INSEMEX Petroşani, it was revealed that - in total lignite dust powdered sediments collected represents 72.85% - 81.73% and the rest is street dust. Given that the coal deposit is not working 365 days/year (there are public holidays, weekends or warehouse is loaded to capacity waiting for delivery etc.) we believe that the admitted concentration/year respectively 200 t/km^2/year is not exceeded.

Table 5. **Particulate sediment**

No.	**Sampling point**	**Month - year 2015**	**Concentration of particulate sediment [g/m^2/month]**	**M.A.Q g/m^2/month STAS 12574/87**	**Exceeding the maximum admitted concentration**
1	Tutunaru I. residence	febr. - oct.	26.42	17	1.5
2	Tutunaru P. residence	febr. - oct.	28.16	17	1.6
3	Brebinaru M. residence	febr. - oct.	18.33	17	1.07
4	Manescu Ghe. residence	febr. - oct.	30.37	17	1,7
5	Popescu I. residence	febr. - oct.	26.73	17	1.5
6	Jilavu C. residence	febr. - oct.	11.45	17	-
7	Mihai M. residence	febr. - oct.	18.73	17	1.1
8	Lupoaia - 110 kw power station	febr. - oct.	7.60	17	-

During 2015 systematic measurements were made at different times, locations of measuring the sketch provided by the customer (EMC Motru), monitoring of noise being made in seven sample points, respectively:

- 34 - 3 m from the house facade of Jilavu Constantin, Roşiuţa village, in the direction of the noise source - facility drive strip 2 motors of 630 kW, located approximately 100 m; secondary noise source - coal transport lanes;
- 35 - 3 m from the house facade of Brebinaru Maria, sat Roşiuţa (near national road Tr.Severin - Motru - Tg-Jiu) direction noise source - driving lane facility with two 630 kW engines and excavators in operation near coal deposit, located approximately 50 m from the point of measurement;
- 36 - 3 m from the house facade of Carlaont, Roşiuţa village, direction noise source - plant drive motor 630 kw + excavator commissioned in the coal deposit, Roşiuţa coal pit;
- 37 - 3 m from the house façade of Mănescu Ghe., Roşiuţa village perpendicular to the noise source - systems drive strip with 2 motors of 630 kW at about 25 m from the point of measurement;
- 38 - 3 m from the house of Vasilescu, Roşiuţa village direction noise source - coal transport lanes shareholders located approximately 50 m from the point of measurement;

- 39 - 3 m from the house of Mihai Mihai, Roşiuţa village direction noise source - coal warehouse equipment (coal conveyor at about 50 m from the point of measurement;
- 40 - 3 m from the house facade, Lupoaia inhabited area, the direction of the noise source - coal transport strip above the forest edge at about 150 m of measuring point.

Identification and location of the main sources of noise fixed and mobile were made by noise measurements at various points, measurements conducted using the methodology prescribed by urban noise monitoring STAS 10009/88 and STAS 6161/1 - 2008. The data monitored by the EPA Mehedinţi, indicator noise outside homes, measured at 3 meters away from inhabited buildings facade, with the microphone at a height of 1.5 m from the ground, perpendicular to the noise source considered for each measurement point in part, it appears that there is exceeding the permissible noise limits imposed by OM no. 536/1997 of 50 dB (A) in daylight (see table 6).

Table 6. **The results of noise measurements - inhabited houses from Roşiuţa and Lupoaia village**

Point no.	**Measurement point**	**Leq limit, dB(A) OMS 536/1997**	**Noise level dB (A)**		
			Leq	**Leq (without traffic)**	**Leq (with traffic)**
1	3 m away from the house's facade of Jilavu Constantin	50 (40)	64	-	-
2	3 m away from the house's facade of Brebinaru Maria	50 (40)	-	63	74
3	3 m away from the house's facade of Carlaont	50 (40)	-	50	59
4	3 m away from the house's facade of Manescu Ghe	50 (40)	-	65	65
5	3 m away from the house of Vasilescu	50 (40)	-	62	64
6	3 m away from the house of Mihai Mihai	50 (40)	-	61	63
7	3 m away from the house's facade, Lupoaia resident area	50 (40)	48	-	-

Limit of 40 dB (A) at night does not exceeded, so it is not adversely affected by industrial activity in the area. It is mentioned that the noise source is the auto transport lignite factories on the road and partially on the national road DN 67. To reduce the risk of environmental emission of dust and noise on some farms in the vicinity of deposit must be taken the following measures: *House decommissioning* for the environmental risk was assessed as significant, namely those between DN67 and Roşiuţa coal deposit (no. 60 - Tricia Arista, No. 58 - Manescu Melania, nr. 51 - Carlaont I., no.50 - Popescu I., No. 49 - Niţoi M., No. 48 - Niţoi Elena, nr. 47 - Brebinaru Maria, No. 45 - Nebunu B.). *Combating pollutants* (dust and noise) from generating sources in compliance with the program of inspections, repairs and maintenance during combat existing protective systems. *Building and planning* a wave of soil between the deposit and the road.

Conclusions and proposals

In the previously studies conducted by ICSITPML Craiova and INCD INSEMEX Petrosani, in terms of environmental risk, it has been proposed solutions and measures for reducing particulate matter pollution and sediment particles and noise. Many of these solutions have been implemented by EMC Motru, reducing significantly the concentrations of particulate matter (measurements made in 2015 did not register any exceeding of allowable CMA), also compared with 2011 dust concentrations sediment (which are non-toxic) measured were lower in 2015, even if it hasn't been reduced below allowable limits. It is believed that after the decommissioning of the eight households (Eg. Trica A., Manescu M., Carlaont I. Popescu I., Nitoi M., Nitoi E., Brebinaru M. and Nebunu V.) and achieving the wave of soil, which will isolate the coal deposit from DN67, the dust pollution will be significantly reduced. Among the unrealized measures, we state: installation of sound-absorbing panels to the deposit's limit and use of fog curtains in points of load-discharge of the machineries for coal dumping. The efforts will be made from EMC Motru, to reduce the pollutants by solving the "step-by-step" goals of the program.

REFERENCES

[1]. **Dumitrescu, I.,** *Poluarea mediului,* Ed. Focus, Petroşani, 2002.
[2]. **Dumitrescu, I.,** *Poluarea şi protecţia mediului*, Ed. Universitas, Petroşani, 2014.
[3]. **Lăzărescu, I.,** *Protecţia mediului înconjurător şi industria minieră*, Ed. Scrisul Românesc, Craiova, 1983.
[4]. **Fodor, D., Baican, G.,** *Impactul industriei miniere asupra mediului*, Ed. Infomin Deva, 2001.
[5**]. Fodor, D.,** *Exploatarea zăcămintelor de minerale si roci utile prin lucrări la zi* (vol 1, 2), Ed. Tehnică, Bucureşti, 1996.
[6]. **Fodor, D.,** *Minerit şi Mediu,* Ed. Corvin, Deva, 2014.
[7]. **Lazăr, Maria, Dumitrescu, I.,** *Impactul antropic asupra mediului,* Editura Universitas, Petroşani, 2006.

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STUDIES ON THE IMPACT OF ACTIVITIES TO DESILTING THE MURES RIVER - FELNAC AREA

DANIELA IONELA CIOLEA *

Abstract: *In Mures riverbed ban imposed by desilting works of riverbed or extracting sand and ballast in the period 16 March to 14 July, considering the negative impact on the protected area perimeter indicated for the respective operational Felnac perimeter. They conducted research, vis-à-vis the listed species optimum period of work in the habitat, mating, breeding, hatching, pregnancy, raising chickens, etc. and in view of their vulnerability.*

Keywords: *environmental protection, legislation, sustainable development, water, protected area, biodiversity, riverbed, impact.*

1. INTRODUCTION

The area under study (Figure 3) is in Felnac area, located in the riverbed of the river Mures, near the left bank, between terminals CSA no. 63, no. 64, approx. 1.8 km north of the town Felnac, Arad in the Mures River basin, basin code IV - 1 and the Lower Mures Floodplain Natural Park, overlaid bird protection area Low Meadow of Mures (ROSPA 0069) and site of Community importance of the same name (ROSCI 0108). [12]

In the riverbed of Mures within the perimeter indicated for exploitation: the perimeter Felnac can perform desilting works of riverbed or extracting sand and ballast 15 July - 15 March without interdiction, in terms of ecology and environmental protection.

All nature undergoes fundamental environmental laws "are all related to all". We can talk about an environment of any biocoenosis, species, populations or individual. A bacterium, a fish, a human, an oak forest or a flower, all have a specific environment. [3]

It points out that the focus is placed the living, regardless of its degree of complexity. Also emphasizes the importance of the concept of "multitude of factors that surround us" and who works as a whole. Therefore, if one or more of these factors are disrupted, the whole must restructure. The changes are greater and manifest negatively, the effort to rebalance the whole is greater. Resilience - the ability ecological systems to return to their original state after some disturbance, is

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increasingly challenged. The acting is rather in the sense of removal from normal parameters of variation; the ability of resilience may weaken, resulting in ecological balances. If spoilers negative amplification, restoring ecological balance is achieved slower and harder. If the action of these factors continues, the ecological balance could deteriorate phenomena occur with rapid succession in the direction of increasing entropy. [1]

2. RESEARCH *IN SITU*

Project analysis *Desilting activities Mures riverbed silt deposits from the perimeter Felnac, Arad County*, it was the first phase of the methodology for project monitoring system which has achieved anthropogenic environmental impact assessment. (Figure 3)

It was analyzed through human impact matrices rating:

- association between project analysis desilting of the Mures river alluvial deposits from the Felnac perimeter, Arad County (relevant shares) and the list of causal factors;

- the association between list of causal factors and ambient components list;

- the association between ambient components list and list areas typologies - Areas Natural Areas - Mures Floodplain Natural Park.

Restriction period of four months for the days when ballast Felnac perimeter, based on documentation, economic principles and expertise in the field, given that the operational area at issue falls in the area of sustainable development.

Desilting works of riverbed or extraction of sand and ballast in the area throughout the year Felnac have impact on the protected area. In conclusion applies operating restriction period 16 March to 14 July.

Explained in the charts below (Figure 1 and Figure 2) for clarity:

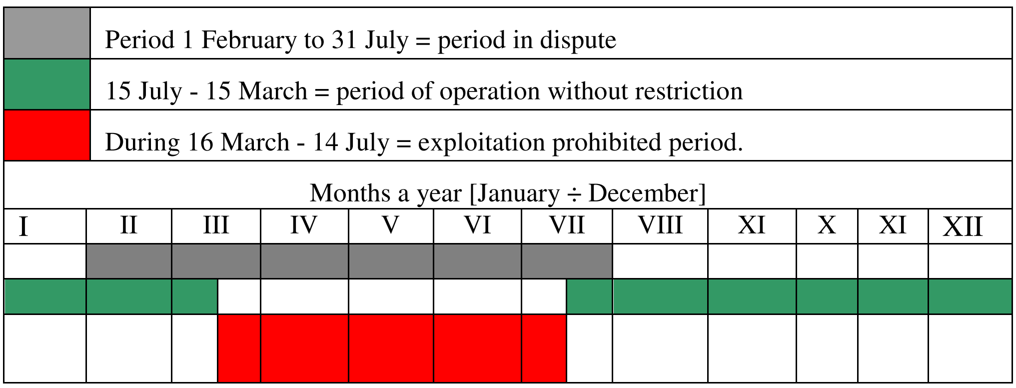

Fig.1. The graph period of exploitation

Months a year [January ÷ December]											
I	II	III	IV	V	VI	VII	VIII	XI	X	XI	XII
			Prohibition fish +		+ Development alevine						
			+ Spermophilus citellus (Gopher)								
		+ Birds									
1 Jan.-15 March		16 March - 14 July				15 July to 31 December					
		Exploitation prohibited period!									

Fig. 2. Graphic detail - after figure 1

The period of prohibition to fish is shown in Table 1 for the year 2008-2014.

Table 1. Prohibition fish in 2008-2014

Lowland waters		Border waters		Prut		Razim Sinoie	
From	up to	from	up to	from	up to	from	up to
01.04.2014	30.05.2014	01.04.2014	15.05.2014	01.04.2014	29.06.2014	01.04.2014	29.06.2014
08.04.2013	06.06.2013	08.04.2013	22.05.2013	08.04.2013	06.06.2013	01.04.2013	29.06.2013
15.04.2012	13.06.2012	15.04.2012	29.05.2012	15.04.2012	13.06.2012	01.04.2012	29.06.2012
04.04.2011	02.06.2011	04.04.2011	18.05.2011	01.04.2011	30.06.2011	01.04.2011	30.06.2011
05.04.2010	03.06.2010	01.04.2010	29.06.2010	01.04.2010	09.07.2010	01.04.2010	29.06.2010
13.04.2009	11.06.2009	15.04.2009	29.05.2009	01.04.2009	30.06.2009	01.04.2009	30.06.2009
15.04.2008	13.06.2008	15.04.2008	29.05.2008	15.04.2008	30.06.2008	15.04.2008	30.06.2008

Desilting works of riverbed or extraction of sand and ballast in the area throughout the year Felnac have a negative impact on protected species in the area.

Between 16 March - 14 July is a time critical or peak (by mating, breeding, hatching, pregnancy, raising chickens, etc.) for most species of protected area Mures Floodplain, this time they are very vulnerable, so work of SC PLOP PERIAM SRL [11] period 16 March to 14 July will lead to a significant negative impact on the protected area.

Period February 1 to July 31 exposed in Table 2:

Table 2. Period 1 February - 31 July

Period February 1 to July 31							
February	March		April	May	June	July	
1.02 - 28/29.02	1.03 - 15.03	16.03 - 31.03	1.04 - 30.04	1.05 - 31.05	1.06 - 30.06	1.07 - 14.07	15.07 - 31.07
Negative impact		Significant negative impact					Negative impact
Can exploit		Forbidden operation!					Can exploit

CONCLUSION

Restriction period 16 March to 14 July desilting works of riverbed or extraction of sand and ballast Felnac perimeter, taking into account the protected species is sufficient, and we must consider the human factor.

From 1 February to 15 March the respective period July 15 to July 31, in terms of the impact on the protected area of Felnac perimeter not impose ban desilting works or extraction of sand and ballast; but in the period 16 March to 14 July in terms of the impact on the protected area perimeter Felnac, it should ban desilting works or extraction of sand and ballast.

Spermophilus citellus (Gopher) is vulnerable species of Community interest and requires strict protection cf. Appendix 4A of 57/2007 [5] on the regime of protected natural areas, conservation of natural habitats, flora and fauna, approved with amendments by Law no. 49/2011. Thus presence and its habitat, may suspend, without comment, any human activities in the area (even at a distance of 200 m), ground squirrels dig galleries as long 30 m to 150 m with depths ranging from 0.8 m - 6 m. To seek reins galleries, gentle slopes, embankments, dikes.

The reproduction period begins a few days out of hibernation (mid-March During this period the males behave aggressively towards each other. Females give birth 2 to 9 chickens, after a gestation period of 25-28 days. Breastfeeding lasts 6 weeks and offspring reach sexual maturity at one year after birth, after hibernation. Also gophers are vulnerable in the period immediately following birth pups - mid-May - late June.

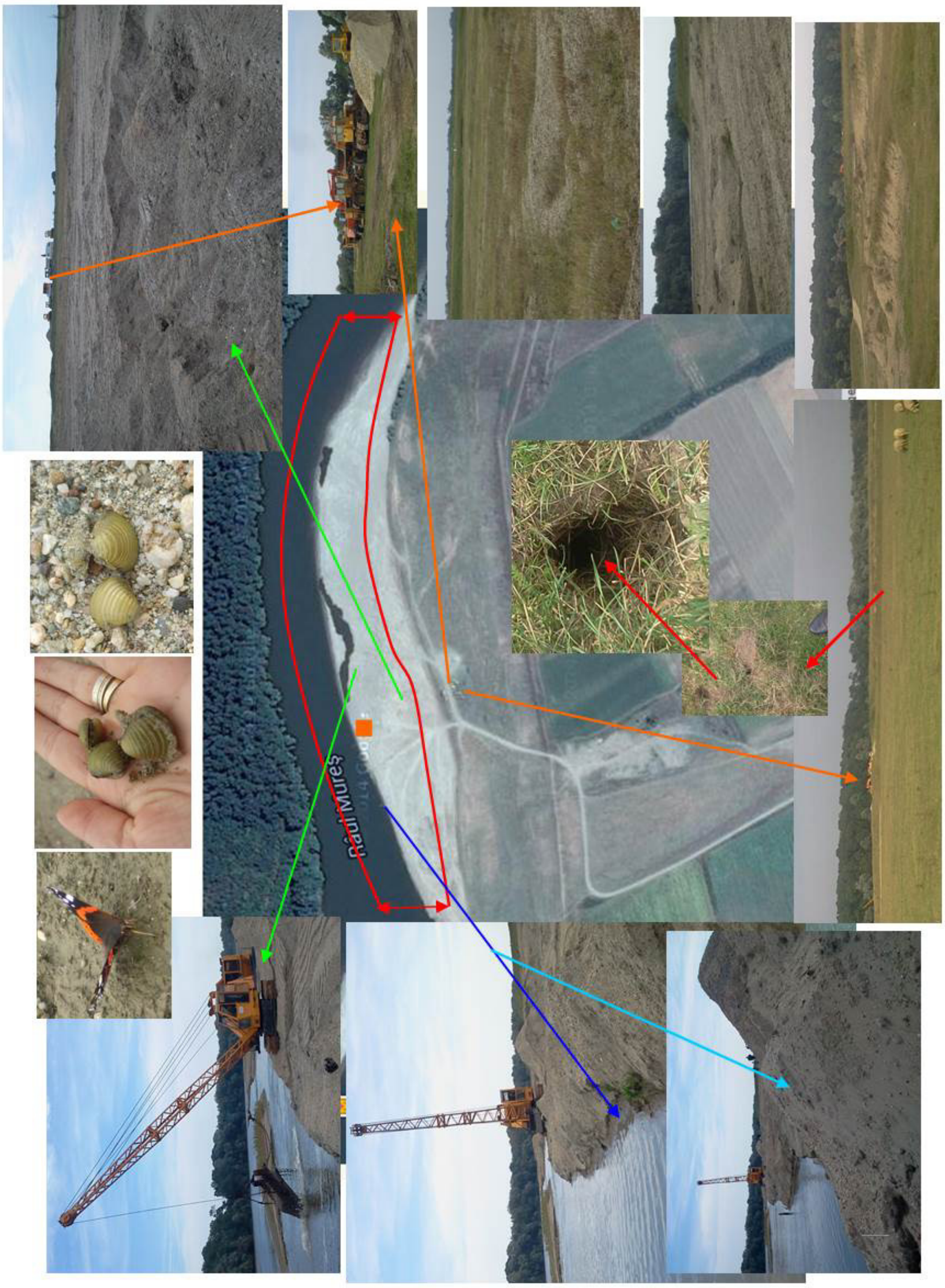

Fig. 3. Images perimeter Felnac-extracting sand and ballast-minor bed river Mures

REFERENCES

[1]. Ciolea D.I. - *Ecologia si protectia mediului*- Curs, publicat pe platforma Interconformity, 2013
[2]. Ciolea D.I., Dunca E. – „*Biologie- Lucrări practice*", Editura Universitas, Petroşani, 2011
[3]. Lungu M., s.a. - *Studiu hidromorfologic din cadrul contractului „Realizarea studiilor necesare si completare a bazei de date referitoare la speciile si habitatele de interes comunitar din Parcul Natural Lunca Muresului"*
[4]. *** Hotarare nr. 1076/2004 *privind stabilirea proceduri de realizare a evaluari de mediu pentru planuri si programe*
[5]. *** O.U.G. nr. 57/2007 *privind regimul ariilor naturale protejate, conservarea habitatelor naturale, a florei şi faunei sălbatice, modificată şi completată de OUG 154/2008*
[6]. *** H.G. nr. 1284/2007 *privind declararea ariilor de protecţie specială avifaunistică ca parte integrantă a reţelei ecologice europene Natura 2000 în România*
[7]. ***Ord. Nr. 19/2010 *pentru aprobarea Ghidului metodologic privind evaluarea adecvata a efectelor potentiale ale planurilor sau proiectelor asupra ariilor naturale protejate de interes comunitar*
[8]. *** Ord. Nr. 135/2010 *privind aprobarea Metodologiei de aplicare a evaluarii impactului asupra mediului pentru proiecte publice si private*
[9]. *** Directiva Habitate nr. 92/43/EEC *privind conservarea habitatelor naturale, a florei şi faunei sălbatice*
[10]. *** Directiva Păsări nr.79/409/EEC *privind conservarea păsărilor sălbatice*
[11]. *** Studiu de evaluare adecvata - *Lucrări de decolmatare a albiei râului Mureş de depozitele de aluviuni din perimetrul FELNAC, judeţul Arad*
[12]. *** Plan de management, 2011 – *Lunca Muresului inferior-ROSCI0108, ROSPA0069*
[13]. *** www.eea.europa.eu, *** www.anpm.ro, *** www.mmediu.ro

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Prof. PhD. Eng. Mircea GEORGESCU

STUDIES ON THE QUALITY OF THE SLUDGE AND MEASURES TO REDUCTION THE NEGATIVE IMPACT

DANIELA IONELA CIOLEA *

Abstract: *In Romania, the sludge is currently stored in WWAT (91%), discharged to waste deposits (9%) or used in agriculture (0,2%). The incineration is not used since Romania doesn't have operating incinerators for solid waste and sludge. The sludge production is a continuous process which implies finding flexible and safe discharging solutions.*

The organic matter content of 50% indicates that the mud is generally stable while the maximum value of 80% is valid for raw sludge (unstable). The average content of dry substance is 22%, typical for dehydrated sludge, but there is a large range between the liquid and very dry sludge.

The storage in ecologic waste deposits is considered the least solution if there are no other environmental and economic viable possibilities. However, the temporary storage is accepted as necessary for a transition period until the water and wastewater operators prepare the beneficial sludge use system.

Keywords: *sludge, research, wastewater, solution, organic matter.*

1. STUDIES ON THE QUALITY OF THE SLUDGE

Average quality scrubber sludge in Romania (RO sludge), weighted with sludge productions [1], [3], is shown in the diagrams in figure sentence 1 ÷ fig. 3. It is found that pH values ranging between 7.5 and 8.29 pH units, which indicates that the sludge has an alkaline condition. (Figure. 1). [6]

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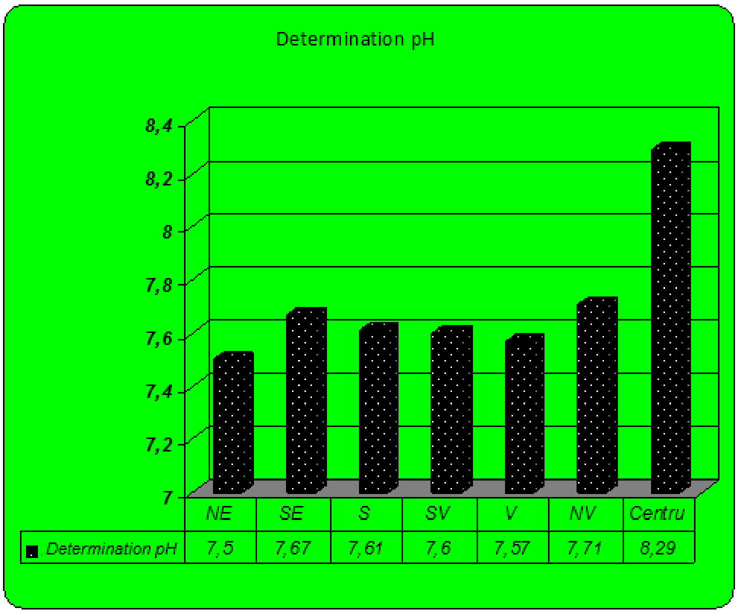

Fig. 1. Identification pH values in samples of sludge-RO

The percentage of dry matter varies between 16.1% and 25% (Figure 2) which indicates significant water content and the use of polymers is not yet well dosed in all urban wastewater treatment plants.

Organic matter in the dry matter percentage varies between 46.4% d.s and 55% d.s (Figure 3). Determination of total nitrogen is found that the percentage varies between 2.98% d.s. and 4.26% d.s.

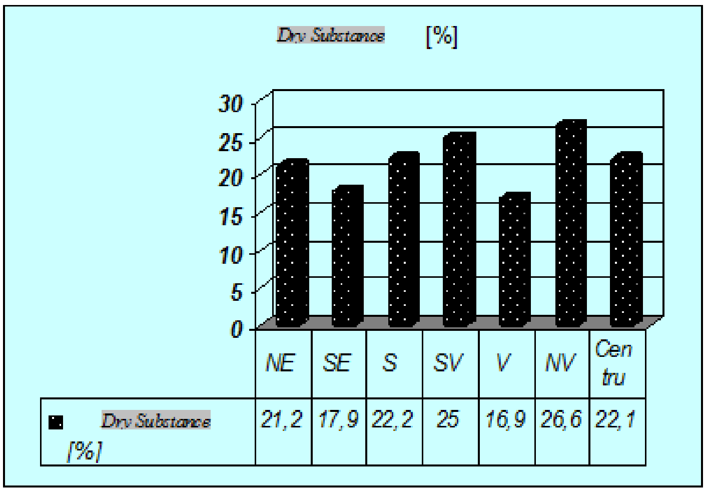

Fig. 2. The percentage of dry substance in the sludge samples-RO

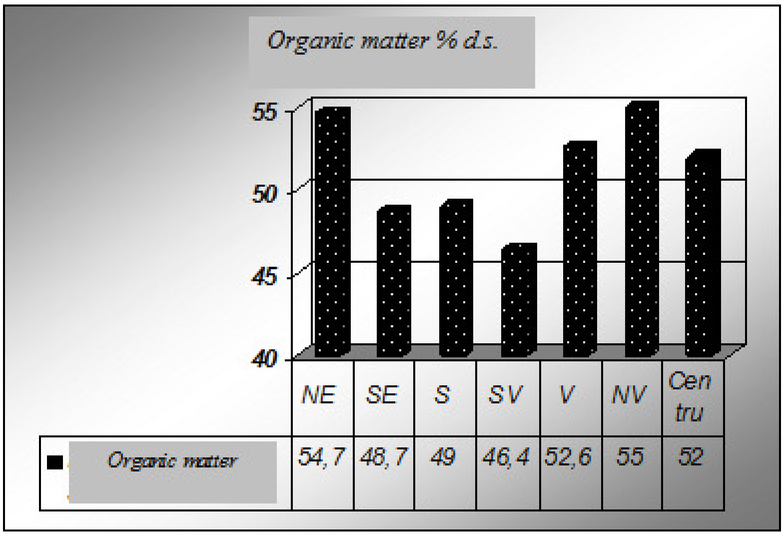

Fig. 3. Organic matter in the dry substance percentage

Romania has in most cases a common sewerage system for domestic waste water and meteoric water. [3]

2. RESEARCH ON THE ACTIVATED SLUDGE IS PURIFIED FROM WWTP DANUTONI

In accordance with Directive 91/271 / EEC [5], defined in the Jiu Valley there are two clusters, respectively [4], [6]:

1) Petrosani Agglomeration - includes the localities Petrila, Petrosani, alders, Vulcan and Lupeni. Wastewater is collected through the sewage system and septic tanks and treated in WWTP Danuţoni, the treated wastewater being discharged into the river Jiu;

2) Uricani Agglomeration - includes the town of Uricani. Wastewater is collected through the sewage system and septic tanks and treated in WWTP Uricani treated water being discharged into the river Jiu. Line treatment is used both to treat sludge treatment plant in Danuţoni and quantities (smaller) of sludge generated in the WWTP Uricani and water treatment plants in the Jiu Valley.

Danuţoni WWTP is in the southern part of Petrosani, approx. 500 m from the confluence of Jiu East and Jiu West, next to the national road 66 A. Danuţoni WWTP serves Petrila, Petrosani, alders, Vulcan and Lupeni and discharging treated effluent into the river Jiu. The original station was built in 1970 and included a barbecue on the access point to the station, three sedimentation tanks and sludge drying beds for storage. [4] Scheme Danuţoni wastewater treatment plant after the expansion is shown in Figure 4.

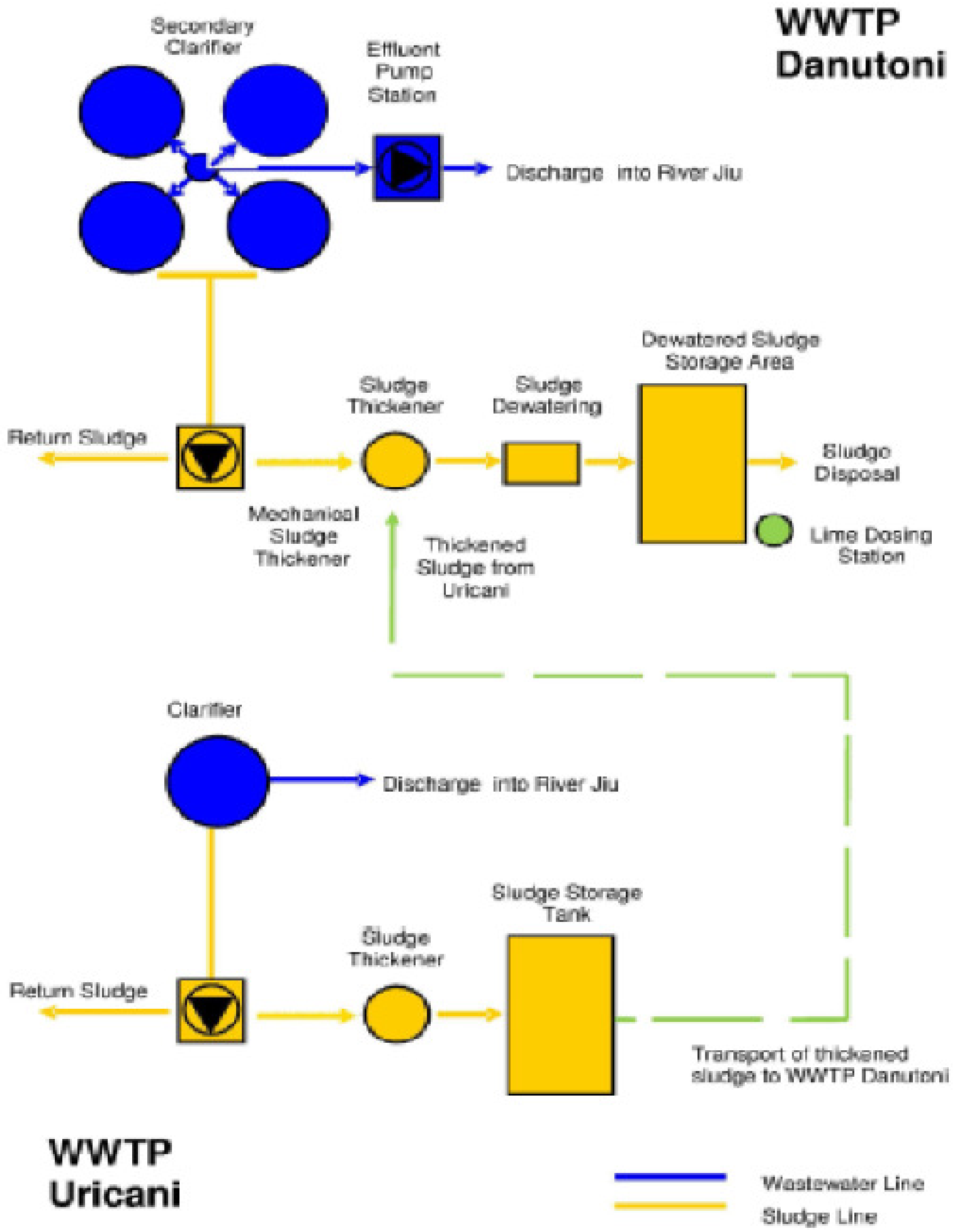

Fig. 4. Scheme Danuţoni wastewater treatment plant

3. PRESENTATION THE EXPERIMENTAL PLATFORM IN SITU

The use of sludge on drying beds inside the WWTP Danuţoni for setting up an experimental platform took into account intake of the chemical elements (sludge used) that are inserted into the ground and must not exceed the reference values in legislation. The arrangement of the experimental platform were considered the recommendations contained in the study prepared by soil and agrochemical OSPA Hunedoara Deva [2] related to the species and how to plant them. They have prepared 900 acacia saplings that were planted after formula 2x1. (Figure 5)

Planting seedlings of acacia was made in April 2016 in the pits with sides of 60 cm and depth of 70 cm has been introduced dewatered sludge from the old drying beds after recipes $R_1 \div R_5$. The amount of sludge used ranged percentage and planting respected 2x1 formula, according to the study conducted soil and agrochemical. I realized observations the evolution seedlings basically at a height of approx. 40 cm after planting; they reached 100 days height of 150 cm (R_4) - 160 cm (for R_5). [6]

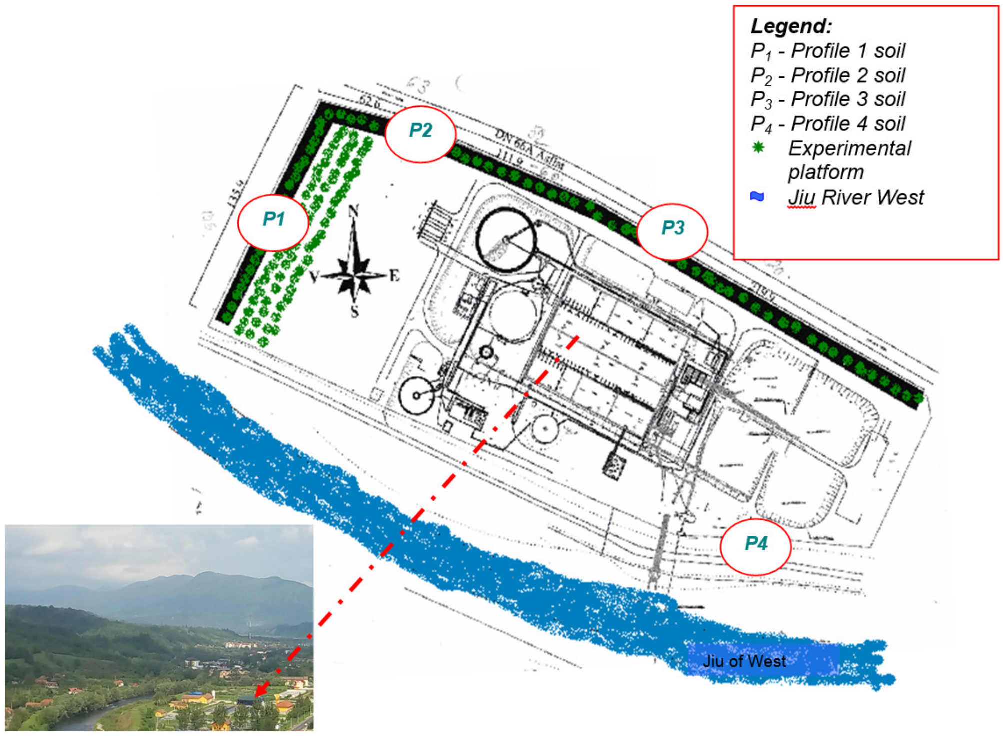

Fig. 5. The picture experimental platform [6]

Were sampling acacia (Figure 6), which were carried in laboratory Ecopedologic, where they were made observations macroscopic and microscopic, performing a series of tests in order to influence the chemical elements in the composition of the sludge used as fertilizer at planting saplings locust.

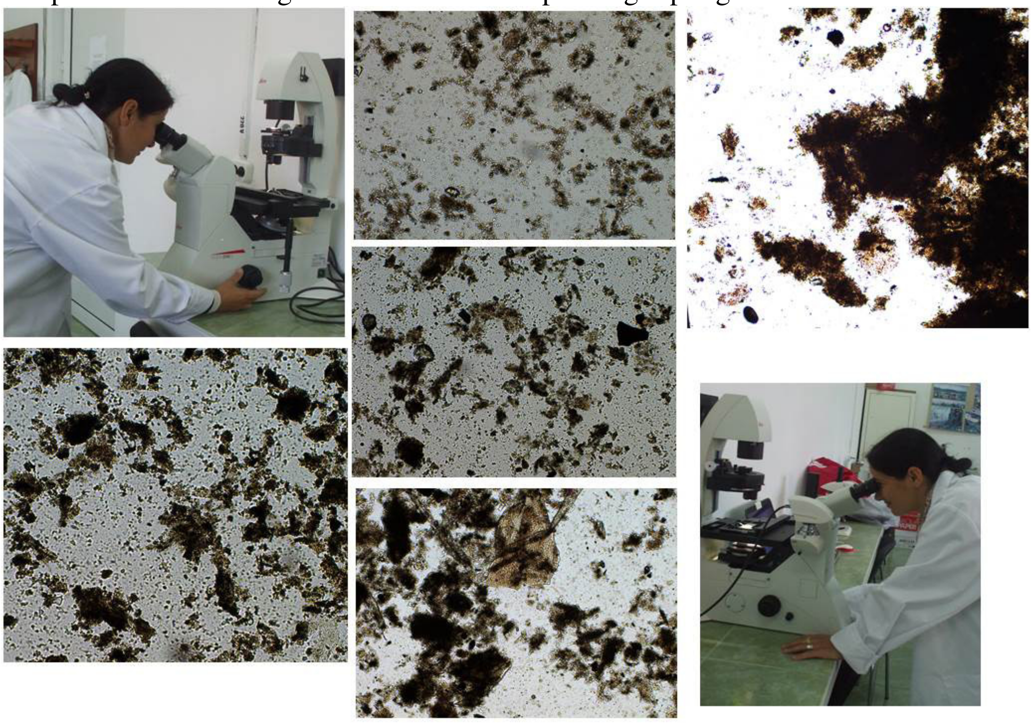

Fig. 6. Microscopic images using Leica DMi8 [6]

A series of microscopic observations (Figure 6) took place on sludge samples treated with polymers taken after obtaining biogas from sludge fermentation in metantanc.

4. CONCLUSIONS

Following theoretical and experimental research on the life cycle of sludge from urban wastewater treatment are issued following conclusions:

- To avoid the negative impacts of environmental pollution and human health is necessary for the administration of sludge to take account of socio-economic and legislative criteria that are more restrictive.
- Reduction measures in realizing the negative impact from sewage sludge can be classified in three lines of research:
- Primary measures - applied before treatment, separation of storm water from the sewage, equipping operators with wastewater pre-treatment, the use of fat separators etc.
- Secondary measures, measures the smooth process flow: electrokinetic's disintegration and decay ultrasonic particle sludge; treatment with polyelectrolyte et al.

➢ Final measures to eliminate / sludge recovery: biogas, agriculture, degraded lands, forestry, nurseries, dumps, incineration, construction material, underground spaces in landfills for treated sludge.

➢ The sludge treatment processes are identified:

- ✓ a thickening - homogenization (gravitational sedimentation, flotation, centrifuging and filtration);
- ✓ a fermentation - composting, anaerobic digestion, aerobic fermentation, chemical stabilization;
- ✓ a conditioning (with inert chemical, thermal, freezing);
- ✓ a dehydration (platforms, filter press, vacuum filter, centrifugal, rotary concentrator, filter belt press);
- ✓ a dry (drying with tiered hearths, rotary dryers, solar drying);
- ✓ a total oxidation (incineration, wet oxidation);
- ✓ a final discharge (agricultural fertilizer, storage, building material, soil conditioning agent, evacuation underground).

➢ For effective management of sludge apply principles of practicality, flexibility, acceptability in terms of the environment, safety and sustainability, cost-efficiency.

➢ Depending on the options for the use of sludge should be differentiated measures to prevent, contain, mitigate and counteract the negative effects on the environment.

➢ Measures primary, secondary and final turn involves other measures namely legislative, institutional, technical, administrative, economic, logistical and financial.

➢ Safety sludge disposal, environmental protection and financial affordability are the principles that influence the viability options feasible.

➢ There is virtually no standard solutions, research all options, namely sludge recovery and cooperation with third parties entail costs and sludge quality must meet certain values required by law.

➢ In Romania the majority of urban wastewater treatment plants process enters the sewage and rainwater (meteoric).

5. PERSPECTIVES OF RESEARCH

- ➢ Study and design solutions for the storage and pre-treatment of individual storm water (rain) separated from the sewage.
- ➢ Learning to treated sludge disposal in underground spaces in the Jiu Valley mining.
- ➢ Recipe testing: 30% sludge + 55% + 10% tailings dump material ash settling pond + 5% PET "noodles" for construction materials.

REFERENCES

[1] *** *Studiu de fezabilitate. Strategia de eliminare a nămolului - Valea Jiului*, 2012
[2] *** *Studiu pedologic şi agrochimic*, OSPA Hunedoara Deva, 2012
[3] *** *Strategia naţională de gestionare a nămolurilor de epurare*, 2012
[4] *** *Strategia actualizată de management al nămolului şi Plan de acţiune actualizat, pentru faza II de investiţii, termen mediu şi lung,* S.C. APA SERV Valea Jiului S.A., Petroşani, 2012
[5] *** *Directiva nr. 91/271/CEE privind epurarea apelor uzate*
[6] Ciolea D.I. - *Măsuri de reducere a impactului negativ în valorificarea nămolurilor de la staţiile de epurare,* Raportul III de cercetare ştiinţifică pentru Teza de doctorat, Universitatea Tehnică din Cluj Napoca, 2015.

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STUDIES ON WASTE DEPOSIT LIPOVA AND ENVIRONMENTAL PROTECTION

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Abstract: *The paper play real situation of non-compliant waste repository where waste Lipova come from various economic operators, private management, social economo units etc. Waste deposit site is in unincorporated town Lipova, non-hazardous solid waste deposit, str. Timişorii, FN, ex Lipova to Neudorf, 2.5 km from DJ 682, CF nr. 301821 - Lipova. Lipova between the landfill and there Cioiloc Valley built an earth dam with length 200 m. [11] Water fire there built a sump in the ground, with approx. 25 m^3, powered Valley Cioiloc, warehouse inconsistent Lipova (waste deposit) as expected and mentioned in the Environmental Authorization [1] no. 10183 of 19.07.2013, revised 29.10.2013, page 17, line 18, Ch. V, pt. 4.*

Keywords: *environmental protection, deposit, waste, legislation, biogas, fire.*

1. INTRODUCTION

According to a study conducted by Eco-Rom packaging, currently a Romanian urban generates on average about 346 kg of household waste* / year, while rural people produce on average up to 3.5 times less (about 95 kg of household waste* / year). Where*: *household waste* = packaging waste plastic, metal, paper, and glass; recyclable waste other than packaging, residual waste (food scraps, for example). [14]

Basically, under the action of internal and external factors wastes decompose and ferment the organic matter quickly; the aerobic / anaerobic waste results in the creation of "pockets" of biogas. [15]

The danger of self-ignition increase with mixed waste fermentation intense because the warehouse has facilities for the collection and dispersal of fermentation.

Lipova is stored in the warehouse following types of waste [5], [10]:

- ✓ waste from agriculture, horticulture, etc. of food preparation;
- ✓ waste from thermal processes;
- ✓ waste from health care activities;
- ✓ waste from waste treatment plants from wastewater treatment plants;
- ✓ urban wastes of commerce, industry and institutions;

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- ✓ construction and demolition waste.

2. RESEARCH *IN SITU*

At research of land (2 March 2016) it was shown in the floodplain Valley Cioiloc a water jump, (and waste, grass, phytoplankton, roots, sediments, eroded soil, mud, etc.) there dug between earth dam and creek Cioiloc. [12]

Garbage / Water Valley Cioiloc could not and can not take the place of a water collecting tank fire, because it was not properly equipped technical; Water from the pit (with the power system, overflow, valve, sealing the water storage, etc.) it has been used to fire on 5 July 2014 and even now does not meet the technical requirements of a sump. "Garbage / water" is carved into the floodplain Valley Cioiloc between earth dam and creek Cioiloc, Figure 1.

"Garbage / water" is located at a distance of approx. 2 meters at the base of the dam, and approx. 3 meters downhill to earth dam, spanning Valley Cioiloc, Figure 2.

"Water pit" is in the floodplain Valley Cioiloc on the left bank of the Valley Cioiloc. But cf. situation Plan-framing area can be interpreted as "water pit" is inside the plots CF 5009 and CF 5010 Lipova no. topo 5724/4, 5724/1, 5724/2, 5724/3 unified by Resolution no. 56 of 28.06.2002 of the City Council on unification Lipova plots entered in CF 5009 and CF 5010 Lipova and the destination of the "garbage dump" for 50990 m^2 surface, cf. plan and employment situation in the perimeter area deposit entered in CF 301821 Lipova / CF 7650 Lipova, no. topo. 5724 / 1- 4. [13]

Fig. 1. Identification "collector Basin?" = "Water pit", 2 March 2016

Fig. 2. Location basin and river Cioiloc

Environmental Authorization no. 10183 / 07.19.2013 revised on 29.10.2013, is approved by the Environmental Protection Agency Arad [1], the fire occurred 5 July 2014, was well as bodies empowered to declare that approved a permit that does not correspond scripting and technical, reality on the ground, long before the day of the fire. There in the alleged artificial lagoon pool or the amount of stored water needed for fire fighting.

In the field, we identified area (approx. 50 m^2) where the fire took place on 5 July 2014, we determined the distance to the "pit water" and found the absence of a form of technical / non-technical supply and distribution of water in case of fire.

No tank / for water / on-site waste deposit; there are sand / soil that has not been used since Saturday, 5 July 2014, at 7:30 am the fire was unstoppable methods rudimentary, and firefighters were announced.

Thus spoke Fire SVSU Lipova with machine 1600 *l* water (the necessary 10 feeds from Lipova), Fire Zabrani with car 2000 *l* water (as required four feeds from

Lipova) and Fire Bârzava with autospecial 9000 *liters* of water (the required three feeds Lipova). So a simple calculation supplies water to fire 05/07/2014 was:

(1600 *liters* x 10) + (2000 *liters* x 4) + (9000 *liters* x 3) = 51000 *liters* of water;

Shuttles transported water from a distance of approx. 12 km.

Earth dam (Figure 3) is located in the unincorporated town Lipova FN from 2 km DJ 682 Lipova -Timişoara, in the river valley Şiştarovăţ left bank of nocadastrate Cioiloc, CF Lipova 301821, topo 5724 / 1 - 4 adjacent pit garbage, and part of protection of the waste deposit by 5,009 ha from floods Cioiloc Valley. [10]

Water fire there built a sump in the ground, with approx. 25 m^3, powered Valley Cioiloc, warehouse inconsistent Lipova (waste deposit) as expected and mentioned in the environmental permit no.10183 of 19.07.2013, revised 29.10.2013, page 17, line 18, Ch. V, section 4. I quote: "*Water Fire constructed a sump in the ground, with a capacity of about 25 m^3, supplied Valley Cioiloc*".

I believe that there was intention to build a sump for water in case of fire, but so far this has not materialized. SC ECO LIPOVA SRL, according to Law. 50/1991, has no regulatory documents issued for the construction of a pool possible.

The research of land (2 March 2016) we were shown in the floodplain Valley Cioiloc a pit with water (and waste, grass, phytoplankton, roots, sediments, eroded soil, sludge, etc.) which there dug between earth dam and creek Cioiloc. Garbage / Water Valley Cioiloc could not and can not take the place of water collecting tank fire, because it was not technically equipped accordingly; pit water has not been used to fire on 5 July 2014 and even now does not meet the technical requirements of a water collecting tank fire.

The storage area itself is max. 25000 m^2 (2.5 ha floor area, with a height of 4 m waste storage), almost half of the total area of the site, which extends to 50990 m^2 (5 ha cf. CF 301821). The waste deposit was commissioned in 2002 and is situated on a hillside next hill.

Waste deposit will stop / will cease in July 2017. Determining the amount of waste is done indirectly, depending on the capacity and density transport waste repository does not have a car weighing platform. Representatives existing SC ECO LIPOVA Ltd, on the ground that the old leadership, not taught *"Registry entries amount of waste SC ECO LIPOVA SRL for 2013 or 2014,"* they told us the situation for 2013 - the amount of municipal waste deposit: 8318.92 tonnes respectively for 2014 - the amount of municipal waste deposit: 5624 tons. Lipova are reported only for the city of 6100 people, although the 2011 census shows 10313 people. I think that only reported paying (6100 pers.), but waste and to "*non-member individuals*", all end up in the landfill Lipova. Noting the situation and villages Zabrani (4472 pers. but reported in 2470 pers.), Paulis (4120 pers. but reported in 2211 pers.) Ghioroc (pers. 3667 but reported in 2632).

Warehouse Lipova longer reach 500-600 m^3 / month waste collected by SC G & E INVEST SRL in 3 cities (Nădlag, Santana, Pecica), and 150-220 m^3 / month waste collected SC PANIPROD H & R SRL in 11 municipalities (Siria, Barsa, Moneasa, Bocsig, Desna, Archis, Gurahonţ, Almas, Dieci, Plescuţa, Chisnidia), and in 2012 filed and SC ECOINEU PHARE 2004 SA wastes (949.60 tonnes) collected from 9 common (Târnova, Seleuş, Şicula, Cermei, Apateu, Craiva, Beliu, Taut, Şilindria).

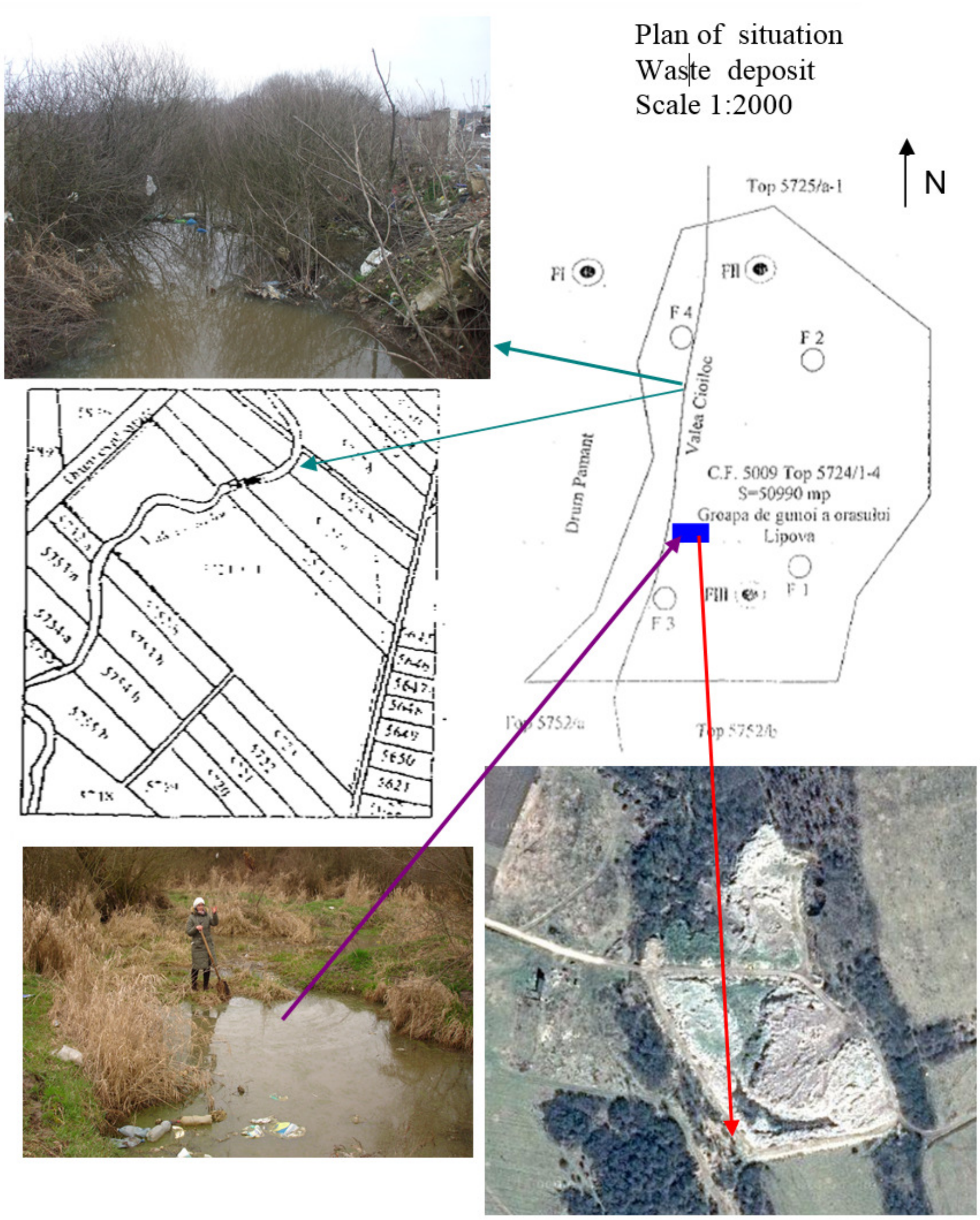

Fig. 3. Plan of situation

3. CONCLUSIONS

The danger of self-ignition increases with intense fermentation of mixed waste, as landfill does not have facilities for the collection and dispersal of fermentation.

Water from the "pit / water" is subject to changes in rainfall regime, in that it can dry up or flood can, depending on rainfall. On the day of the fire pit does not have the ability and opportunity to provide the necessary water for fighting fires on non-compliant waste repository. There is no technical possibility and in fact lead to an amount of water in the pit area where the fire manifested.

The waste deposit was commissioned in 2002 and is situated on a hillside next hill. Waste deposit will stop / will cease in July 2017.

REFERENCES

[1]. *** *Autorizaţia mediu nr. 10183/19.07.2013, revizuită în data 29.10.2013*

[2]. *** *Legea. nr. 104/2011 – Legea calităţii aerului înconjurător*

[3]. *** Directiva nr. 99/31/CE *privind depozitarea deşeurilor*

[4]. *** Ordinul nr. 756/1997- *Evaluarea poluării mediului*

[5]. *** Legea 211/2011 privind *regimul deseurilor*, republicata 2014

[6]. *** Legea nr. 50/1991 privind autorizarea executarii constructiilor

[7]. *** Ordin nr. 119/04.02.2014 pentru aprobarea *Normelor de igienă şi sănătate publică privind mediul de viaţă al populaţiei*

[8]. *** Hotarâre nr. 856/16.08.2002 privind *evidenta gestiunii deseurilor si pentru aprobarea listei cuprinzând deseurile, inclusiv deseurile periculoase*

[9]. *** *Ghid privind managementul deşeurilor*

[10]. *** *Raport la bilanţul de nivel I pentru depozitul de reziduuri menajere a oraşului Lipova*, iulie 2012

[11]. *** *Aviz de gospodărire a apelor nr.8/18.05.2011 privind DTAC „Dig de pământ la groapa de gunoi Lipova", 2011*

[12]. *** *Plan de intervenţie în caz de accidente (incendiu, poluări accidentale) al depozitul de deşeuri nepericuloase Lipova*

[13]. *** *Studiu geotehnic- Construire dig de pământ la groapa de gunoi Lipova*, 2011

[14]. *** www.eea.europa.eu, *** www.anpm.ro, *** www.mmediu.ro

[15]. Ciolea D.I. – *Poluarea mediului-Indrumator de proiect*, Editura Universitas, Petroşani, 2014, ISBN 978-973-741-306-2.

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GESTION D'UN SITE MINIER POLLUEE POTENTIELLEMENT - LAGOON LE TRIANGLE DES MARIENAU - FORBACH

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Résumée: *La gestion des sites, dont le sol a été pollué directement ou indirectement par des activités industrielles (exploitation minière), s'effectue dans le cadre de la loi sur l'environnement. Le sujet de cet article doit résoudre le problème de la sécurité et de la réhabilitation éventuelle de la lagune du «Triangle de Marienau». La gestion d'un site dans le contexte de sols pollués repose sur l'estimation du risque réel pour l'environnement, en particulier la santé humaine et la qualité de l'eau des aquifères, en fonction de l'utilisation prévue du site. La connaissance des mécanismes de mobilisation et de transfert joue un rôle tout aussi important à cet égard que l'identification de la présence d'un contaminant à un endroit donné.*

Key words: *polluted, mining, management, lagoon, contaminant, rehabilitation, risk*

1. INTRODUCTION

La gestion des sites, dont le sol a été pollué directement ou indirectement par des activités industrielles, est effectuée dans le cadre prévu par la loi du 19 juillet 1976 relative aux installations classées pour la protection de l'environnement partie intégrante du Code de l'Environnement. [2, 15]

La politique française est précisée par plusieurs circulaires notamment:

- la circulaire du 3 décembre 1993 relative à la politique de réhabilitation et de traitement des sites et sols pollués;
- la circulaire du 7 avril 1996 relative à la réalisation de diagnostics initiaux et de l'évaluation simplifiée des risques sur les sites industriels en activité;
- la circulaire du 10 décembre 1999 relative aux principes de fixation des objectifs de réhabilitation. La prescription de tels travaux fait généralement suite aux différentes démarches définies par les circulaires du 3 décembre 1993, du 3 avril 1996 et du 31 mars 1998:

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- ***travaux d'urgence***: clôture, signalisation, enlèvement des déchets dangereux présents en surface;
- ***évaluation simplifiée des risques*** sur la base d'un diagnostic initial avec, si nécessaire, la mise en place d'une surveillance de site, notamment par l'installation de piézomètres;
- ***diagnostic approfondi et évaluation détaillée des risques***.

La gestion des sites et sols pollués est basée sur l'estimation du risque effectif pour l'environnement, en particulier la santé humaine et la qualité des eaux de nappes, en fonction de l'usage prévu pour le site. La politique française se différencie de celle d'autres pays basés sur des seuils a priori de teneur en polluant. [8, 15]

De façon schématique, les grands principes de la politique nationale, en matière de sites et sols pollués, peuvent se résumer ainsi:

- ***Prévenir,***
- ***Traiter /Réhabiliter,***
- ***Connaître.***

Ces principes visent à aborder plus de deux siècles d'histoire industrielle de la France de manière pragmatique, tout en tenant compte des exigences sociales actuelles. Ils doivent permettre d'éviter de renouveler demain les erreurs du passé. [13, 15]

Ils s'appuient sur le constat que le problème essentiel est celui des risques de transfert. Ce n'est pas tant la présence de polluants dans les sols (source) qui est problématique, mais le fait que cette pollution soit mobilisable (transfert), et donc qu'elle risque d'affecter une population (cible). La connaissance des mécanismes de mobilisation et de transfert joue à cet égard un rôle largement aussi important que l'identification de la présence d'un contaminant à un endroit donné.

Parmi les centaines de milliers de sites industriels passés ou actuels recensés (base de données BASIAS), quelques milliers de sites seront sélectionnés comme susceptibles d'être pollués (base de données BASOL) en fonction de l'activité exercée, de la sensibilité de l'environnement et des incidents ou accidents connus. [6]

Chaque site susceptible d'être pollué doit faire l'objet d'un diagnostic initial (analyse historique complétée par des prélèvements et analyses sur le site et dans son environnement) et d'une Evaluation Simplifiée des Risques (ESR) pour l'homme et la ressource en eau.

Cette Evaluation Simplifiée des Risques permet à partir de grilles de notations standard, de classer les sites de la façon suivante :

- *à banaliser (apte à l'usage sans autre précaution);*
- *à surveiller (généralement analyse périodique des eaux sur et hors du site);*
- *à approfondir.*

Chaque site à approfondir doit faire l'objet d'investigations approfondies (prélèvements et analyses détaillées pour mieux connaître la source de pollution, les modes de transfert possibles et la sensibilité des cibles). Ces investigations ont pour but de concevoir et de préciser les différents schémas possibles de transfert des polluants de la source vers la cible et de les modéliser dans l'espace et dans le temps. Sur ces bases, une Evaluation Détaillée des Risques (EDR) pour l'homme, la ressource en eau, les écosystèmes et les biens matériels, permettra d'étudier, si besoin est, la faisabilité d'un traitement ou de classer le site à surveiller.

2. PRINCIPE DU TRAITEMENT DES EAUX RÉSIDUAIRES À LA COKERIE

Tout les résidus solides, poussier de coke, charbon et eaux usées (purges de chaudières, purges de circuit d'eaux de réfrigération, eaux de lavage, eaux pluviales) était envoyés dans 2 décanteurs bétonnés. De là, l'eau décantée était envoyée vers 2 lagunes à ciel ouvert pour traitement biologique. Le détail des opérations effectuées sur les résidus est visible sur la figure nr. 1. [11]

Les boues étaient produits carbonie décantées dans les 2 décanteurs et lagunes ont été déposées dans le trois bassins constituants ce que l'on appelle le ″Triangle de Marienau″.

La méhode dite de lagunage a été utilisée pour traiter l'eau résiduaire de la cokerie de Marienau. Cette technique a permis la destruction naturelle des résidus par les microorganismes. Cette opération nécéssitait de très importantes surfaces de bassins car le processus naturel de déveoppement des bactéries est long. De plus, ces vastes étendues sont beaucoup plus sensibiles aux variations de température, le froid réduisant considérablement l'activité des bactéries. Les lagunes naturelles agissent souvent de façon anaérobique ce qui, du fait du manque d'oxygène est cause de dégagement gazeux malodorants. Pour éviter ces nuisances olfactives, on préfère une dégradation en milieu oxygèné que l'on obtient par brassage de l'eau à l'aide d'agitateurs. [9]

La lagune aérée se comporte donc comme un système de traitement des déchets. Le temps nécessaire au déroulement du processus est de l'ordre de quelques jours à quelques semaines.

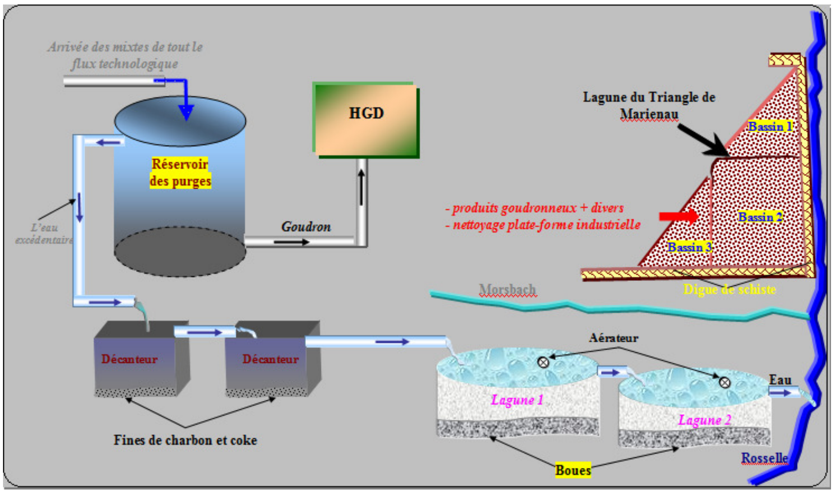

Figure nr. 1 Méthodologie de dépotoir dans la Lagune du „Triangle de Marienau" pour les déchets résoudre de la cokerie de Marienau

L'épuration biologique, des eaux résiduaires, grâce à l'intervention de microorganismes (bactéries), englobe les différents processus qui conduisent de la diminution à l'élimination des pollutions par les phénols et autres matières oxydables. Ce type d'épuration agit plus particulièrement sur les polluants organiques. [3]

On peut dire que les traitements biologiques sont des opérations efficaces pour réduire la pollution due aux ***phénols***, ***cyanures*** et ***sulfures***. Par contre, leur action sur l'ammoniaque est nettement insuffisante, en effet, pour éliminer celui-ci il faudrait que coexistent dans le processus différentes bactéries spécialisées, en particulier des bactéries capables de nitrifier l'ammoniac.

Le schéma ci-dessus présente le principe de cette biodégradation (figure nr. 2.).

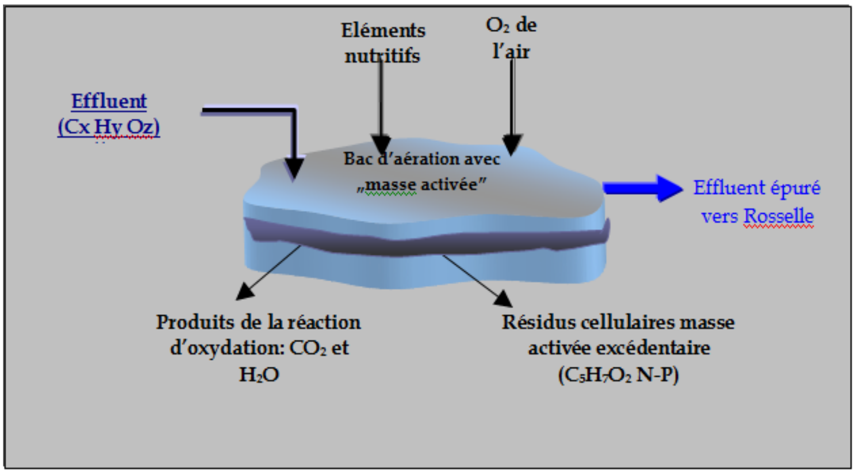

Figure nr. 2. Le de biodégradation d'eau résiduelle

En l'absence de „*masse active*" (flore bactérienne), l'oxydation des polluants organiques par l'air est quasiment nulle. Dans les systèmes de traitement biologique les microorganismes (bactéries) jouent en quelque sorte le rôle de catalyseur d'oxydation des polluants organiques. Aussi, pour obtenir une élimination rapide des divers polluants, l'exploitant a intérêt à augmenter autant que possible la teneur en boues activées des eaux du bac d'aération.

Une partie des boues était recyclée après décantation dans les bassins d'aération et il restait une certaine quantité de boues excédentaires. [5]

Ces boues excédentaires étaient déposées dans les trois bassins dites de la „Lagune du Triangle de Marienau" et l'eau ainsi traitée était rejetée dans la Rosselle.

Sorties des lagunes, les effluents rejetés contienaint en moyenne 500 mg/l phénol, leur demande chimique en oxygène (DCO) était de l'ordre de 3 000 mg/l et leur demande biologique en oxygène (DBO) de 2 000 mg/l.

Les dépôts „*Triangle de Marienau*", estimés à environ 15 000 m^3, étaient constitués la fine non seulement de résidus goudronneux provenant des bacs à mixte et des boues des lagunes mais également d'autre déchets issus du nettoyage de la plateforme industrielle.

3. TRAVAUX ET AMÉNAGEMENT RÉALISÉS SUR LE SITE DU "TRIANGLE DE MARIENAU"

Dans le cadre de la lutte contre la pollution, le Service des Mines a demandé, au début de l'année 1984, aux H.B.L., de trouver une solution au problème posé par les différents déchets déposés dans „Triangle de Marienau". En effet, cette zone a servi pendant 30 ans de dépotoir pour les déchets principalement ceux issus de la Cokerie Marienau. [15]

L'espace en question a la forme d'un triangle rectangle dont le petit côté est long d'environ 120 mètres en bordure du Morsbach et l'hypoténuse est d'environ 300 mètres en bordure de la Rosselle. Plus précisément, le triangle se compose de trois bassins d'une profondeur variable entre 0,7 et 1,7 mètres, séparés de la Rosselle par une digue principale de même longueur ainsi que de autres digues moins importantes. Les digues on était faites dans le cadre des travaux d'aménagement décrit ci-dessous. (Figure nr. 3)

La solution proposée devait permettre de:

- traiter les déchets entreposés et fermer l'entrée du système;
- isoler les déchets de la nappe phréatique.

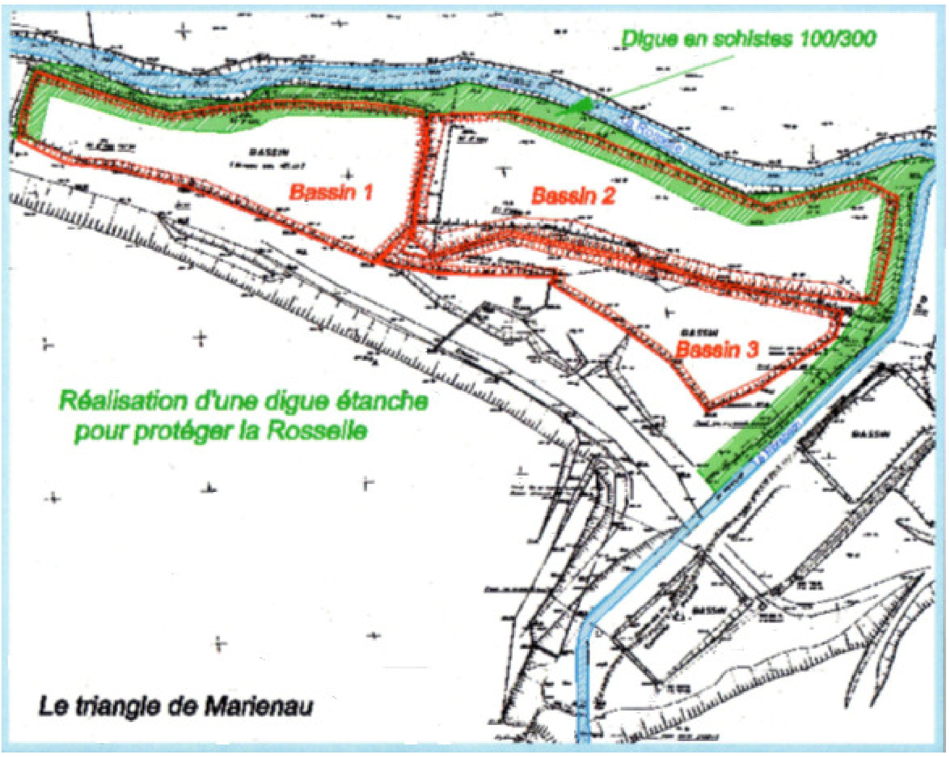

Figure n. 3. Plan de situation avec les bassins de dépotage

Les travaux effectués pendant l'été 1984, à proximité de la rivière Rosselle et du Morsbach ont consisté en premier lieu à la réalisation d'une digue de protection de 2 mètres de haut, de 11 mètres de large et 430 mètres de long. Ces travaux on été effectués avec des matériaux traditionnels (schistes 100/300).

Les travaux ont consisté tout d'abord en un remblai avec de schistes de lavoir dans le premier bassin. Des schistes ont été mélangés avec des boues pour stabiliser et solidifier ces déchets contenus dans le bassin. Une partie des boues est lors apparue en surface. Ces boues ait été pompe et envoyée vers cokerie de Carling pour être traite. []

On a continué à remblaye progressivement avec des schistes et une partie des boues a pu s'infiltrer entre les cailloux. Pour faciliter les travaux d'assainissement de trois bassins, on a construit de petites alvéoles pour mélanger les boues avec les schistes et assurer une stabilisation du terrain afin d'on assurer l'accès par les camions.

Les schistes 100/300 se sont révélés des matériaux tout à fait appropriés pour stabiliser les terrains mouvants, permettant le passage des camions par fortes pluies et absorbant la boue.

3.1. Première tranche des travaux

Compte tenu des essais réalisés dans le bassin nr. 1, le traitement des boues a été réalisé comme suite:

- réalisation de petites alvéoles sépares par de digues;
- remblayage progressif pour permettre aux boues de s'infiltrer entre les cailloux;
- pompage des boues excédentaires;
- nivellement.

Les zones remblayées de cette manière sont restées stables et aucune résurgence de boues n'a pu être observée. Sous réserve de traiter les boues en excès lors des ces travaux, il était donc possible d'envisager cette technique pour le traitement de ces boues.

3.2. Deuxième tranche de travaux

Les travaux de remblayage en schistes on été réalisés pendant l'été 1985 par l'entreprise COCHERY. Ils comprenaient:

- la construction de digues transversales pour la réalisation de petits bassins;
- le remblayage d'une partie du bassin supérieur (bassin III);

Les remblayages des zones instables en bordure des bassins.

La méthode employée a permis de fixer les boues sur une grande étendue mais présentait l'inconvénient de ne traiter qu'une partie des déchets. Les boues en excédent non traités niveau du bassin supérieur (bassin III), qui a pu s'écouler dans le bassin non encore remblayé (bassin II). La partie surmontant la digue a été évacuée dans le bassin inférieur (bassin II) lors de la troisième tranche de travaux.

3.3. Troisième tranche de travaux

Un remblayage par cendres humides sur une partie du bassin III on a réalisé. Les cendres ont été déversées en bordure du bassin et poussées directement sur la surface des boues à l'aide d'un bull de marais (Figure nr. 4). La méthode qui nécessitait une couche d'environ 150 cm de cendres humides, présentait de sérieux inconvénients:

- ✓ nécessité d'isoler des petits bassins séparés par des digues en schistes;
- ✓ remontée de goudrons lors de la circulation d'engins non munis de chenilles;
- ✓ déplacement d'une partie des goudrons;

Nécessité de recouvrir les cendres par une couche de finition pour éviter les envols.

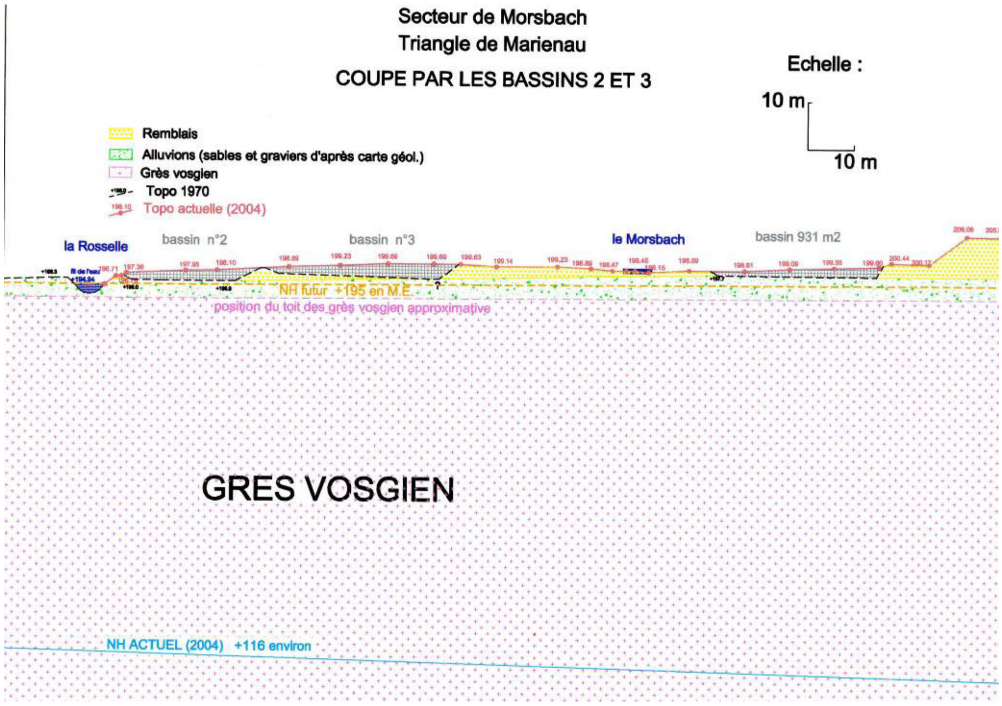

Figure n: 4. Coupe par bassins n. 2, n. 3 et décanteur n. 1

Une partie des cendres humides livrées a été utilisée pour étancher la digue longeant la Rosselle.

Des essais effectués au laboratoire de la Cokerie Marienau ont montré qu'il était possible de solidifier la boue du „Triangle de Marienau" avec des cendres volantes. A condition de réaliser un mélange suffisamment intime, la solidification était réalisée dès l'ajout d'environ 30 % de cendres. La méthode a été expérimentée en trois endroits du triangle.

4. CONCLUSIONS

Le périmètre du „Triangle de Marienau” est situé dans la partie sud-ouest de l’ancienne cokerie de Marienau, sur le confluent de la rivière Rosselle et du ruisseau Morsbach. L’historique de ce site commence avec la mise en service de la cokerie de Marienau.

La cokerie de Marienau a construit deux décanteurs bétonnés pour décanter la fraction de goudron qui arrive par l’eau de procès avant qu’elle ne soit envoyée vers les lagunes d’aération.

Les matériaux des décanteurs étaient envoyés vers trois bassins.

L’arrêt de la cokerie de Marienau a été effectif en 1987, mais sur le site du „*Triangle de Marienau*”, les travaux de réhabilitation ont commencé en 1984 et ont été terminés en 1986.

D’après les recherches que nous avons effectuées, un dépôt des produits décantés a débuté à cet endroit sans étude préalable car il y avait un point bas à proximité d’une berge naturelle. Il s’est poursuivi tout au long de la vie de la cokerie.

Les premiers travaux effectués sur les trois bassins ont consisté à construire une digue de protection vers la Rosselle et le Morsbach pour éviter l’écoulement des boues vers ces cours d’eau.

Les travaux de réhabilitation de la lagune ont été réalises avec du schiste de lavoir et des cendres volantes pour solidifier et ainsi stabiliser les boues.

Le „*Triangle de Marienau*” repose sur des alluvions sableuses et graveleuses: ce terrain est très perméable.

Après un nouveau levé topographique, on peut voir le niveau actuel et futur de la nappe phréatique, sur le site étudié. On peut dire que il y a la possibilité que les bassins 2 et 3 soient susceptibles d’être inondés dans le futur quand la nappe remontera, en cas de conditions pluviométriques exceptionnelles conduisant en particulier à une forte crue de la Rosselle.

Jusqu'à présent, on n’avait pas d’analyse chimique des matériaux qui ont été déposés dans ces bassins, de telle sorte que l’on ne sait pas si la pollution existe ou non. Dans le même temps, nous n’avons pas d’analyses sur la qualité d’eau de la Rosselle, On ne sait donc pas s’il y a lixiviation des éléments chimiques et transport par ruissellement vers les cours d’eau.

Il n’y a pas de piézomètre mis en cette place pour surveiller le niveau et la qualité de la nappe phréatique sur ce site.

On connaît la chimie d’eau de procès qui a résulté de la cokerie. On sait qu’elle était chargée en phénols, sulfates et cyanures, et l’on peut supposer qu’une partie de ces éléments chimiques soit restée dans les boues qui se sont déposées dans les trois bassins. S’il y a tous ces éléments chimiques, il existe un risque de contamination de la nappe phréatique quand elle remontera.

BIBLIOGRAPHIE

[1.] F. Meinck, H. Stooff H., Kohlschutter - *Les eaux résiduaires industrielles* Masson et Cie, Paris 1970.
[2.] P.J. Wils on, J.H. Wells - *Charbon, coke et sous-produits.* Librairie Polytechnique Ch. Beranger, Paris 1953.
[3.] M. Daniel - *Le traitement de eaux résiduaire des cokeries*. ATS 1973.
[4.] J. Bernot, R. Chantereau - *Traitement biologique des eaux de cokerie.* ATS 1968.
[5.] J. Bebin - *Le lagunage aéré*. TSM L'eau novembre 1973
[6.] S. Hains, K.E. Martel, D. Millette, R. Samson, L. Deschenes - *Etude du potentiel d'atténuation naturelle d'un site à pollutions mixtes résultant des activités d'une ancienne cokerie*. Ecole Polytechnique de Montreal. CRSNG en assainissement et gestion des sites. 2001.
[7.] x^{x}x - *Guide méthodologique du BRGM – MATE.*
[8.] x^{x}x - Etude 153–P.V. n°6 – Station Expérimentale de Marienau – *Eaux résiduaire de cokeries*. Septembre - octobre 1974
[**9.**] **x^{x}x** - Centre d'études supérieures de la sidérurgie française – *Traitement des eaux résiduaire***.** Maizières-lès-Metz 1991.
[10.] x^{x}x – H.B.L. - SESA *Estimation de l'impact du lessivage des sols de la cokerie de Marienau sur l'eaux d'exhaure*, ANTEA 1996.
[11.] x^{x}x – *Impact sur la nappe des Grès du Trias Inférieur de l'ennoyage des exploitations minières du Bassin Houiller Lorrain. Etude hydrogéologique générale*, ANTEA 1998.
[12.] x^{x}x – *Ancienne cokerie de Marienau* (57). Etude de faisabilité de traitement. ANTEA 1994.
[13.] x^{x}x – *Dossier renseignement minier secteur «vallée de la Rosselle***»**. GSA 2004.
[14.] x^{x}x – Centre de Pyrolyse de Marienau – *Traitement du gaz. L'Environnement. Evolutions des techniques prospectives*. Maizières-lès-Metz 1991. Tome 4.
[15.] x^{x}x – Emilia Dunca - *Etude et mise en sécurité des lagunes du Triangle de Marienau. Propositions de traitement éventuel et de réhabilitation*. Thèse professionnelle de fin d'études soutenue en séance publique en vue de l'obtention du diplôme de Mastère Spécialisé en Traitement des Evolutions et Mutations Industrielles. Nancy, France, 2004.

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IDENTIFICATION, ASSESSMENT AND MONITORING OF THE IMPACT GENERATED BY THE ROVINARI THERMOELECTRIC POWER PLANT

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Maria LAZĂR **
Florin FAUR ***

Abstract: *Since the advent of the industrial age, human society became more and more dependent on energy in its various forms (thermal, mechanical and electrical), but none of these forms of power were more revolutionary than electricity. The capability to transform and store thermal and mechanical energy into electrical energy allowed for greater production, mechanization and an overall increase in the quality of life, yet this phenomenon came at a cost. The most efficient way to satisfy the world's energy needs so far has been through burning fossil fuels, an activity linked with high environmental impact and great risks regarding safety and sustainability. The following paper aims to present the environmental impact generated by Rovinari thermoelectric power plant.*

Keywords: power plant, environment, impact assessment, monitoring

1. INTRODUCTION

Thermoelectric power plants use thermal energy obtained through burning fossil fuels in solid, liquid or gaseous form. The transformation of thermal energy into mechanical energy is realized with turbines (with spark or diesel ignition). Of the thermoelectric power plants, the most used and most complex are the ones using steam powered turbines, able to also produce thermal energy for industrial and urban heating. Thermoelectric power plants are denoted with CTE, and thermal power plants are denoted with CET.

Thermoelectric power plants produce, at present, the highest percentage of electrical energy generated in Romanian power grid. **CTE Rovinari** is among the most important thermoelectric power plants in the country, with a total installed power of 1320 MW - power generated by its four groups 3,4,5 and 6 (each with a nominal installed power of 330 MW).

The components of a thermoelectric power plant are unto themselves complex aggregates, composed of the boiler unit, turbine-generator unit and energy distribution

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network. The power plants also have a series of installations and auxiliary equipment, meant to ensure the functionality of the main aggregates, like fuel preparation and feeding stations, water preparation and feeding stations, workshops and laboratories, deposits, etc.

Advantages of using coal as an energy source consist in: is a cheap and economically stable energy resource; is abundant due to exploitation infrastructures already in place; prices to establish infrastructures are lower than alternatives; high availability, (it can be easily stored until is needed, regardless of environmental conditions); high energetic density; easy to burn, generates a high amount of energy compared to other energy sources; the technology used in coal power plants is versatile, easily adapted to individual needs.

Disadvantages of using coal as an energy source: generates high quantities of emissions and other noxious compounds (sulfuric and nitric oxides, carbon dioxide, dust particles, etc); it is not a renewable energy source; coal exploitation implies risks for people and the environment; it has a high impact on ecosystems.

2. SOURCES OF POLLUTION AND EMISSIONS

2.1. Description of CTE Rovinari

Rovinari thermoelectric power plant is located in Gorj county, on the west bank of the Jiu river, and are two main burning installations (M.B.I.):

- **M.B.I. 1** consisting of: boiler unit nr. 3 - 1035 t/h, 878 MWt, working since 1976; boiler unit nr. 4 - 1035 t/h, 878 MWt, working since 1977;
- **M.B.I. 2** consisting of: boiler unit nr. 5 - 1035 t/h, 878 MWt, working since 1977; boiler unit nr. 6 - 1035 t/h, 878 MWt, working since 1979;

Characteristics of the four main power units are as follows:

- **Boiler** - lone forced throughput (Benson type), tower type, licensed under Babcock, using Rovinari lignite coal as fuel, steam temperature 540°C, feeding temperature 260°C.
- **Steam powered turbine** – FIC type, 330 MW, condensation turbine, with lone intermediary overheating with "acting" element, licensed under Ratem-Schneider.
- **Electric Generator** – Alston type, maximum continuous power output of 330 MW, economical power output of 315 MW and an overcharge power output of 345 MW, 3000 rotations per minute (RPM).

Lignite coal is used as the main fuel, oil fuel is used to support combustion and methane gas is used for the ignition process. The lignite for which the installation is scaled has a specific energy output of about 1600 kcal/kg, volatile gas contents of 20.3%, average humidity of 48% and ash content of 24.5%. [3]

2.2. Data regarding the emissions

The operations within a power plant based on coal combustion generates a series of pollutants that through the synergic effect produces an impact especially on the atmosphere (emissions of carbon dioxide, carbon monoxide, sulphur dioxide, nitrogen oxides and particulates), but also on waters (due to the release into the emissaries of industrial water with a temperature higher by up to 10°). Also, there may be heavy metal emissions, but in very small quantities, noise pollution and radioactive pollution.

Law no. 104/2011 regarding the Quality of Ambient Air provides the maximum admitted values for atmospheric pollutants, as follows [5]:

- Nitrogen dioxide - hourly limit value - 200 µg/m^3 (not to be exceeded more than 18 times in a year); the annual limit for human health protection -40 µg/m^3; and alert threshold - 400 µg/m^3. Nitrogen oxides are gases that contribute to acid rain formation, creating a major impact on the environment and facilitates the formation of ozone in the troposphere.
- Sulphur dioxide - hourly limit value - 350 µg/m^3 (not to be exceeded more than 24 times in a year); the limit value for 24 hours for human health protection -125 µg/m^3; and alert threshold -500 µg/m^3. Sulphur dioxide also generates acid rain.
- Carbon monoxide (CO) – limit value for the maximum averages in 8 hours (moving averages) - 10 mg/m^3. Carbon monoxide is a greenhouse gas and is harmful to human health.

Particulate matter (PM10 fraction) were measured by gravimetric and automatic methods. These particles can be inhaled and they represent a risk factor for the health of living organisms.

Table. 1 presents the overruns of limit values (LV) for these pollutants, as reported by Gorj Environmental Protection Agency.

Table 1 Emission measurements at GJ-2 – Rovinari station [4]

Pollutant	MU	Type of overrun	Number of overruns
SO_2	µg/m^3	Overrun of hourly LV/overrun of 24 hours LV	2
NO_2	µg/m^3	Overrun of hourly LV	0
CO	µg/m^3	-	0
PM10 gravimetric	µg/m^3	Overrun of 24 hours LV	28
PM10 automat	µg/m^3	Overrun of 24 hours LV	29

According to the documents available from the Ministry of Environment, Water and Forests, for Rovinari thermal power plant in the year 2014 there has been recorded an amount of 4,469,942 tons of carbon dioxide emissions. Carbon dioxide is the main greenhouse gas and for emissions overrun, Oltenia Energy Complex pays penalties that led to major financial pressures on the company.

Since the monitoring station GJ-2 - Rovinari is located across Rovinari town and the overruns especially for PM10 can not be attributed entirely on Rovinari thermoelectric plant (being necessary to take into account the dust emissions from neighboring open pits and from auto traffic) for identifying the impact, by networks method, the on analysis was started from lignite exploitation phase (lignite being the main fuel).

3. IDENTIFICATION AND ASSESSMENT OF THE ENVIRONMENTAL IMPACT

3.1. Work methodologies

The procedural scheme of an environmental impact evaluation is a general chart applied in environmental impact studies, which does not depend on a given project, going through the same framework of analytical techniques and evaluation processes, adaptable to all categories of specific projects. Therefore, the control lists, matrices, impact networks, impact estimation models and different evaluation criteria are all instruments applicable within the frame of environmental impact studies for any projects [1, 2]. The stage of impact identification consists of a series of operations. It aims at identifying certain and probable interactions between the elementary causal actions of the project and environmental components, specific to the area of reference. Before this operation, the project is divided into elementary actions, from which the relevant ones are selected, and are chosen the significant environmental components for the reference area (constituting the steps of a previous operative stage).

To identify and estimate the environmental impact of Rovinari power plant there were used two methods: impact networks and impact matrices.

3.2. Identifying the environmental impact using impact networks

Impact networks are composed of flow charts or multiple relationship chains, which connect the project activities and environmental components susceptible to suffer changes. In identifying the complex of impacts of an activity, impact networks reconstruct the chain of events or potential effects induced by specific actions of a project on the initial environmental conditions, potential changes of environmental conditions, multiple effects of impact and allow proposing possible corrective interventions [1, 2]. Impact networks allow the systematic highlighting of secondary and indirect effects, the existence of multiple relationships and the concomitance of causes and cumulation of effects, taking time span into account (figures 1 – 6).

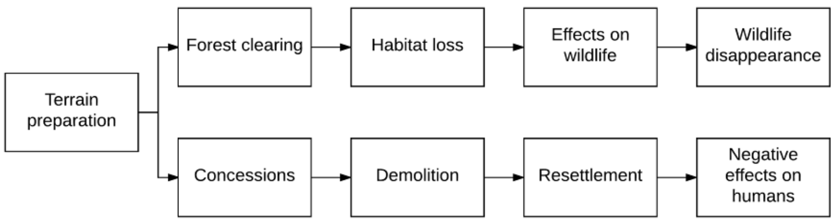

Figure 1. *The environmental impact generated by terrain preparation*

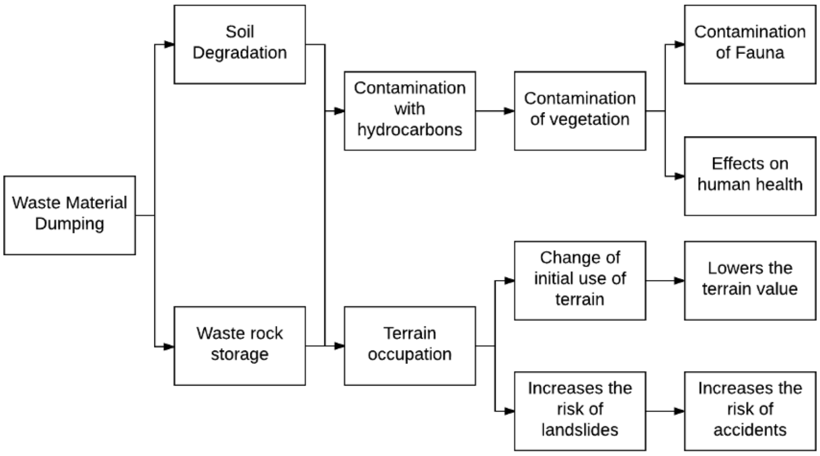

Figure 2. *The environmental impact generated by dumping the waste material*

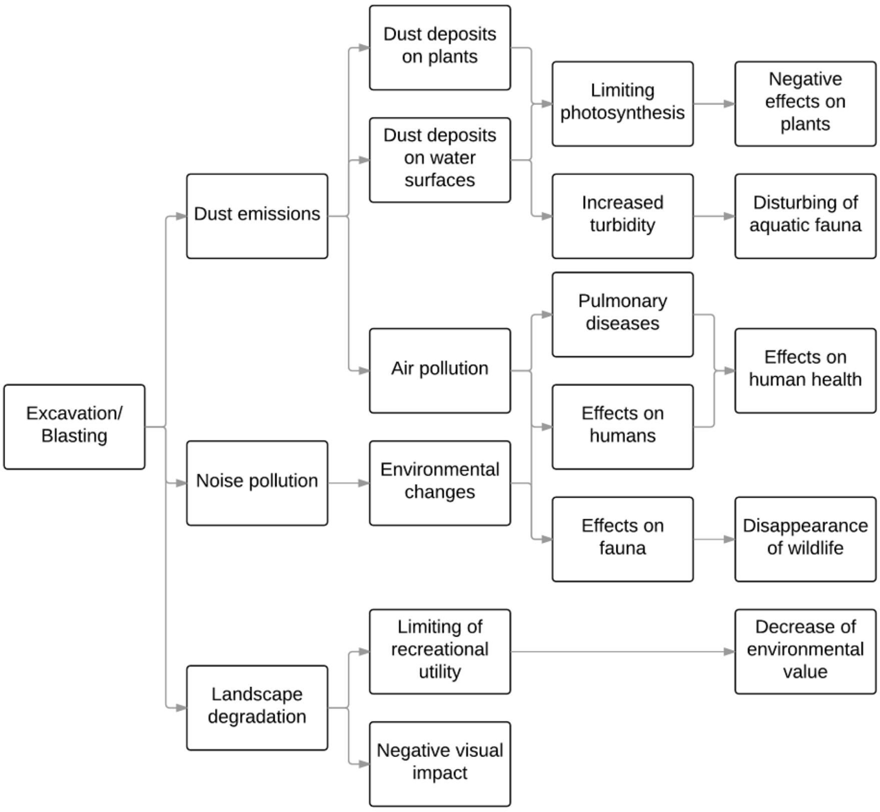

Figure 3. *The environmental impact generated by excavation*

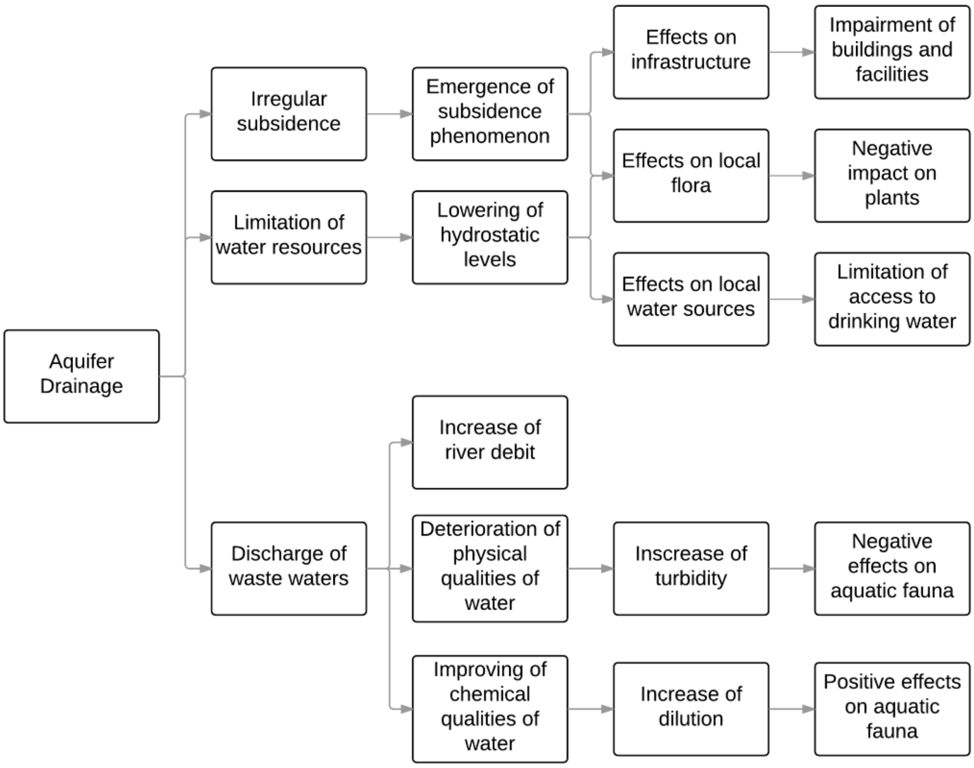

Figure 4. *The environmental impact generated by draining aquifer formations*

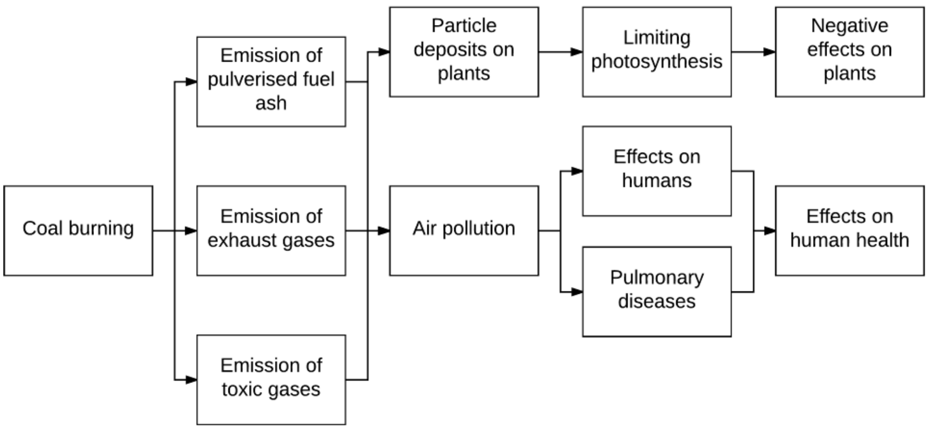

Figure 5. *The environmental impact generated by coal burning*

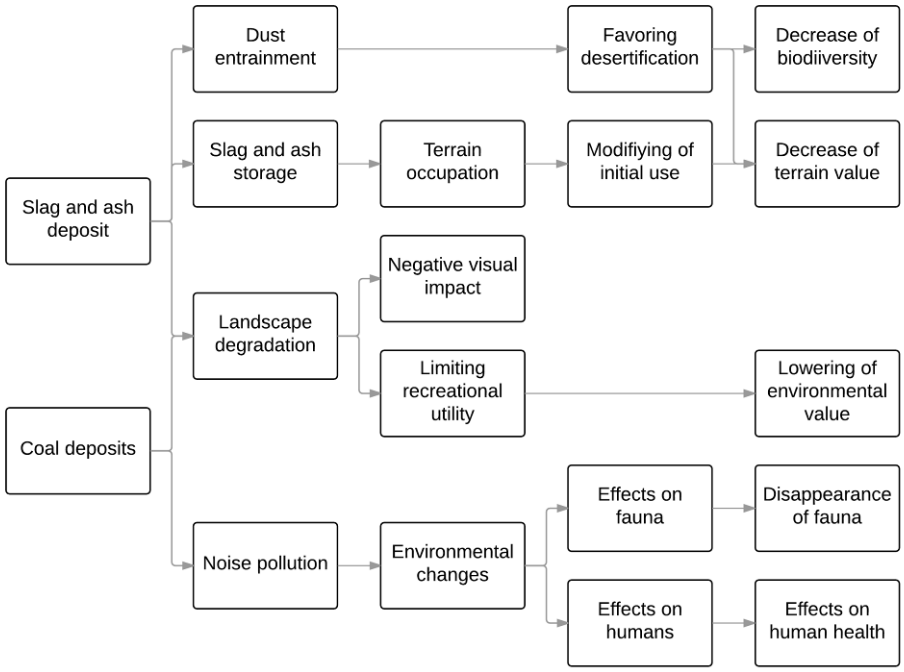

Figure 6. *The environmental impact generated by storage of coal and deposition of ash*

Following the elaboration of impact networks for coal fueled power generation in Rovinari thermoelectric power plant, it can be observed that the major impacts lead to a variety of secondary and tertiary impacts, resulting, due to synergism, in variable effects on flora, fauna, ecosystems, anthropic components in the area and human health.

3.3. Environmental impact assessment using matrices

The matrices are made of tables with double entry, with lines inscribed with the involved environmental components, split and arranged by category, and columns inscribed with elementary actions into witch the analyzed project was divided. Every crossing of the matrix represents a potential impact relationship between project actions and environmental components [1, 2].

The evaluation of primary and secondary impacts is based on the importance (major or minor) of the identified impact and on the character (direct or indirect) of the highlighted relationship. In the matrix presented in table 2 it was considered that all the impacts generated by the causal factors on the environmental components are negative.

For establishing the magnitude of the impact of a certain causal factor on a certain environmental component it was considered that the analyzed objective (namely Rovinari thermoelectric power plant) is located in an industrial area, close to urban environments.

Table 2. *Environmental impact assessment matrix for CTE Rovinari*

Environment		Causal factors											
Environmental categories	**Environmental components**	Macropollutants emissions	Micropollutants emissions	Radioactive emissions	Noise emissions	Water consumption	Wastewater discharge	Surfaces flooding	Soil occupation	Soil waterproofing	Auto traffic	**SUBTOTAL**	**TOTAL**
Atmosphere	Air quality	3	3								2	8	15
	Microclimate	2	3								2	7	
Water resources	Surface waters	1	1			2	2					6	7
	Ground waters									1		1	
Ecosystems	Fauna	1	1		2	1	1				1	7	13
	Flora	2	2			1	1					6	
Soil, subsoil and morphology	Soil	1	1						2	1		5	7
	Landscape	1							1			2	
Physical environment	Noise level				3							3	4
	Radiation			1								1	
	TOTAL	11	11	1	5	4	4	0	3	2	5	46	

The numbers in the matrix have the following significations:
1 – minor impact – manifested at local level, reversible on short term, with minimal consequences on the environment;
2 – medium impact – manifested at local/regional level, reversible on medium term, with notable consequences on the environment;
3 – major impact – manifested at regional level (and contributing to global impacts such as: global warming, climate change, acid rain etc.), reversible on long term (or irreversible), with severe consequences on the environment;

Analyzing the matrix from table 2 it can be observed that the most affected environmental categories are represented by atmosphere and ecosystems, while the most aggressive causal factors are represented by the emissions of micro and macro pollutants. It should be underlined that the total of 46 represents an instrument meant to verify the correct summing on rows and columns, and it can not be used to compare the overall impact generated by CTE Rovinari with another project.

Based on the total scores obtained for the environmental components and causal factors it can be established the priority for their monitoring.

4. ESTABLISHING THE NEED FOR MOINITORING

Using the environmental impact assessment matrix from table 2, the causal factors and environmental components are ranked (tables 3 and 4), in order to determine the prioritization of their monitoring.

Depending on the repartition of causal factors and environmental components within the priority classes, it can be chosen the order and measure in which to allocate resources towards their monitoring.

Table 3. *Ranking of monitoring needs for the environmental components*

Rank	Environmental categories	Environmental components	Points a	Points b
1	Atmosphere	Air quality	8	15
		Microclimate	7	
2	Ecosystems	Fauna	7	13
		Flora	6	
3	Water resources	Surface waters	6	7
		Ground waters	1	
4	Soil, subsoil and morphology	Soil	5	7
		Landscape	2	
5	Physical environment	Noise level	3	4
		Radiation	1	

Table 4. *Ranking of monitoring needs for causal factors*

Rank	Causal factors	Points
1	Macropollutants emissions	11
2	Micropollutants emissions	11
3	Auto traffic	5
4	Noise emissions	5
5	Water consumption	4
6	Wastewater discharge	4
7	Soil occupation	3
8	Soil waterproofing	2
9	Radioactive emissions	1
10	Surfaces flooding	0

Following the ranking of the affected environmental components and of the causal factors it can be noticed that the main environmental components affected by Rovinari thermoelectric power plant are air quality, microclimate and fauna followed by surface waters and flora, while the main causal factors responsible for the impact are represented by the emissions of macro and micro pollutants, followed at a considerable distance by noise and auto traffic. These conclusions indicate the need to elaborate a monitoring system for these environmental components/causal factors, and reduce their specific impact through different methods.

At present, the emissions are monitored discontinuous (due to functionality problems of the continuous monitoring system), with a weekly frequency, using the following types of equipment: TESTO 350 XL; OLDHAM Opacimeter;

The values obtained during the discontinuous monitoring of emissions will be inscribed in a table, in order to maintain a reliable data base, and the interpretations will be made according to HG nr. 541/2003 regarding limit values for emissions of M.B.I. Normally these measurements are made continuously allowing for an integrated monitoring process of the four main groups functioning at Rovinari thermoelectric power plant and the immediate intervention over some problems that might occur during their work cycle.

CONCLUSIONS

When the environmental impact was identified through networks method, it was considered the life cycle of lignite (the main fuel) from the exploitation phase up to its transformation into energy respectively the storage of the residues generated in the process (slag and ash).

Analyzing the results, it is clear that the major impacts generated by Rovinari thermoelectric power plant are represented by greenhouse gas emissions or acid rain generating gases, as well as dust particles.

In order to reduce the emissions generated by the power plant and return it to functioning according to the law, there must be applied measures to retain the pollutants at source according to GD 322/2005 and GD 833/2005 (national approval program regarding reduced emissions).

Other possible measures are the use of best technologies available for carbon dioxide capture (in order to reduce the emissions), or its underground storage.

Regarding the other impact forms generated by Rovinari thermoelectric power plant, the waste water discharged must respect the NTPA 001/2005, in order to maintain the river course within allowable limits.

Although experimental, there are already technologies being built that allow thermoelectric power plants to function with close to zero emissions, suggesting that impacts generated by the thermoelectric power plant can be reduced in such a way that these technologies can compete with "green" technologies in which regards the emissions. A limiting factor to these new technologies is the high, prohibitive price.

BIBLIOGRAPHY

[1] Lazăr M., Dumitrescu I., Anthropic impact on the environment (in romanian), Universitas Publishing House, 2006.

[2] Lazăr M., Faur F., Identification and assessment of the anthropic impact on the environment. Project guide (in romanian), Universitas Publishing House, Petrosani, 2011.

[3] Lazăr M., Faur F., Considerations on the Influence of Extraction Technology of Lignite in Open Pits Over the Production Quality, International Multidisciplinary Scientific GeoConference: SGEM: Surveying Geology & mining Ecology Management, Bulgaria, 2012.

*[4] *** - Gorj EPA - Report regarding the air quality in Gorj County (in romanian), 2015.*

*[5] *** - Law no. 104/2011 regarding the Quality of Ambient Air.*

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REHABILITATION STUDY OF STERILE DUMPS NEAR PETRILA TOWN

CIPRIAN NIMARĂ *
IOAN DUMITRESCU **

Abstract: Through the mining activities and minerals processing, spaces in relative equilibrium, change their dynamics through a regressive acceleration, generating other landscapes which operate in a high degree of entropy. Geomorphologic elements are modified, new superficial formations are created and accelerates the soil physicochemical processes. The total area from Petrila town which was affected by the coal exploitation and which must be rehabilitated is over 30 ha. The aim of this paper is to present a rehabilitation model of this area.

Key words: mining exploitation, coal, environment, dump, rehabilitation, Romania

1. LOCATION AND OVERVIEW OF THE MINING ACTIVITIES

Petrila town is located in Hunedoara county, Romania and the administrative area has the following localities: Jiet, Cimpa, Petrila (residence), Rascoala, Tirici. The administrative territory of Petrila is bordered to the east by Şureanu Mountains (Patru's Peak at the north), Parang Mountains in the south and Petrosani town in the west. The town is located at 675 m altitude, on the banks of Eastern Jiu river and is attested in various documents from 15 century (1493 and 1499).

The mining exploitation from Petrila is part of Petrosani Mining Basin, where the coal is stationed in 25 layers of sediment horizon 2 or "lower productive", where the economic features have the layers: 3, 5, 13, 15, 17, 18. Layer 3 is the most important in the basin due to large expansion in almost all perimeters. The thickness varies from 1-50 m and the highest values being known in the eastern part of the basin in the following perimeters: Lonea and North Petrila. Layer 5 is spread in a considerable area in all perimeters of the mining basin. It consists of 4-5 banks of coal and has a variable thickness from 0.5-8 m at the top, presents a constant 0.30 to 0.80 m, called "paprika", because it is self inflammable.

The mining perimeters from the Petrosani Mining Basins are presented in the figure 2.

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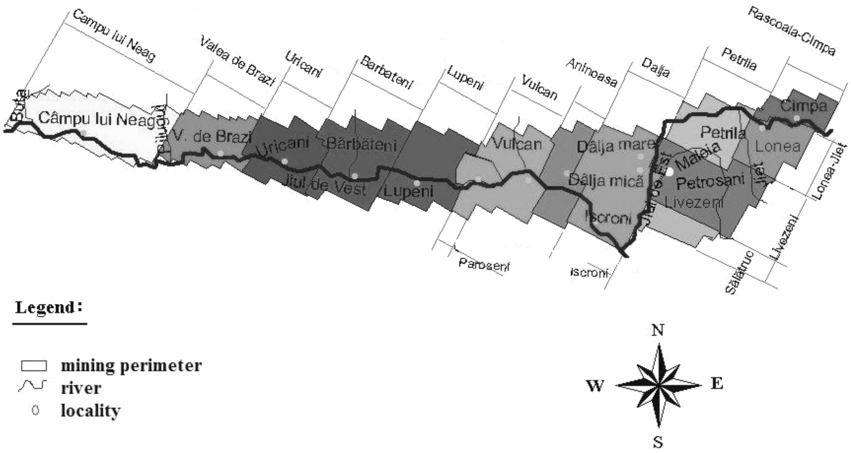

Fig. 1. Mining perimeters from Petrosani mining basins

2. COAL EXPLOITATION AND LAND DEGRADATION IN PETRILA AREA

The social and economic evolution made by the transformations induced to the environmental components and its answer, can be seen by highlighting the relations between the environmental elements, seen in the field. As technological development and spatial extent of anthropogenic areas, there was an increase in conflicting relations with the natural environment.

Underground coal mining has great repercussions on the land surface by causing subsidence, rupture or collapse. These phenomena not only allow normal use of the land, for the initial goals, but also seriously affect the construction's area. The adjacent area of underground mining area is destabilized by mining exploitation, surface water or groundwater seepage, vibration (caused by blasts), explosions, mining transport, that the chance of risk are effective.

The severity of the surface deformation is dependent on assistance from the ground, the level of stress and deformations arising and always have the effect of destroying the stability of the surrounding rock. Fractured rocks on the excavation's perimeter is put in motion, moving into massive which is a function of their ability to fill the resulted gap. If it is very high, exceeding the capacity rock's fragments to fill it and stop such phenomenon rock's deformation, the movement can be transmitted to the ground surface.

Exploitation of thinner coal layers, cause only sinking of the surfaces without compromising crop land; exploitation of thicker layers, where occur different diving areas in the direction of rupture layers, the consequences on land are radically altering their total use. Other undesirable consequences of this activity can be: the drying up of wells, the emergence of new springs, disturbance of groundwater or the formation of permanent lakes in the bottom of sinking areas. Areas affected by rupture and collapse of land following the coal mining, in Petrila mining perimeter is about 4.3 ha and the influence area is 11.36 ha [5].

A specific situation of mining activity from this area is the presence of the abandoned coal pit as a result of the unprofitable economic exploitation (see table 1).

Table 1. **Abandoned coal pits from Petrila mining area and**

Name of the coal pit	Area (ha)	Influenced area (ha)
Cimpa	9,30	0,75
Jieţ Defor	12,56	1,05
Jieţ Vest	6,41	0,50
Total	**17,27**	**2,30**

In the vicinity of Petrila town, is located the dump perimeter (figure 2) which is being developed close to the mining premises and continues to the southern side of the Rusalin river and on the Northern side of Maleia brook. Both are tributary waters of East Jiu [6].

The 2 East dump occupies an area of 2.10 ha and the land on where it is located the dump, was initially a plateau with a slow morphology, with small slopes not exceeding 10°, generally with a direction from South to North slope (table 2).

The five branches of the dump are arranged from West to South in the following order: branch III, I, II, V and IV, with angles of 9°, 14°, 16° and 24°.

Fig. 2. Land degradation as a result of mining activity near Petrila

The subsidence phenomenon is a physical-mechanical mechanism that occurs as a result of the generation of gaps in rocks deposits. Loose of sedimentary deposits induce a redistribution of masses and rearrangement of layers so it results the deformation of the original topographic surface. The process is manifested by the appearance of sinks with different amplitudes [4]. In the Arsului Valley sector, related to Lonea mining area are frequent collapses, subsidence with negative influences on larger areas than the mine site.

Following the discontinuation of mining in the Defor coal pit in 1990, the Defor brook which was diverted during mining works, resumed the old course and the water accumulate in the coal pit, forming a lake with dimensions of 250/170 m, a depth of 20-25 m, water table elevation standing at 745.92 m. The affected valley sector by mining is an area of 12.56 ha [5].

3. REHABILITATION OF THE STERILE DUMPS NEAR PETRILA TOWN

The rehabilitation of the affected areas by the mining activity, requires more than a simple rehabilitation of the functions that the ecosystem had before human intervention and its effects of which were already felt over the relief, soil, water, microclimate and biodiversity. This term implies a reconstruction of the affected area both by its insertion in the environment and in the economic cycle [6].

The obtained landscape, after reconstruction of the affected area by anthropogenic activities, should be aesthetically compatible with the natural landscape or the one from proximity.

In terms of aesthetics, the reintegration actually means to mask the anthropogenic new landforms. Reintegration of affected areas by mining activities is a worldwide challenge.

This involves integration into the landscape of three anthropogenic landforms, namely: positive anthropogenic landforms (dumps), surface excavations (coal pits) and surface water storage (ponds, sludge bed, lakes between dumps). These are the following works that should be carried out:

- emmbankment and terracing works will be carried out on I, II and III dumps in order to reduce the angle of slope and circulation of safe machinery working on redevelopment and re-cultivation. Since around those three dumps there expropriated land areas available which allow extension of the deposit, will use embankment process from top to bottom;
- it is necessary to create the conditions for regeneration of soil fertility on the branches IV and V will be carried a flatwork. Although these works were made by actual dumps technology, cutting-leveling is deemed necessary for defining the profile of the dump where it will be allowed tolerances of ± 10 cm above the reference plane. Bulldozers leveling is achieved with various types and sizes;
- for water drainage must be ensured the slopes of 2-5% for marginal dump drains;
- regarding the work of stopping the active geomorphologic processes of erosion caused by precipitation, may be used small fances of green willow built on wooden poles and positioned at a distance of 2.5 m (for extending their strength, are not recommended in summer);
- for the type of gradient required, may be built and reinforced decking with a 80 cm width, later to be placed over a layer of soil with thickness of 25-50 cm.
- if the surface enables the direct placement of the cover soil without embankment work for planting trees and shrubs exclusive, the thickness will range from 0.5 to 1 m.

When installing the artificial forest vegetation, choice of the woody species is a fundamental issue of the highest importance. To install the forest on degraded land is the first aims to improve soils and land consolidation. For this purpose, the priority is to choose tree and shrub species with high ecological amplitude. Looking on environmental criteria will be promoted species and natural compositions - potentially as close to those of natural ecosystems [1].

Thus the degraded lands of the dump, the proposed species to be used for re-cultivation of the following species: Scots pine (Pinus sylvestris) mixes with sea buckthorn (Hippophae rhamnoides), Spruce (Picea Abies), birch (Betula pendula, Betula thick, Betula verucosa), acacia (Robinia pseudacacia), willow (Salix babylonica), alder (Alnus glutinosa) and different species of roses (Rosa).

CONCLUSIONS AND PROPOSALS

In the ecological management of a territory, parameters that must be taken into account are: local economic system, specific activities, features of system's natural elements, social and urban characteristics of the system and regional aesthetics.

Knowing the decay stage of the regional geomorphologic system is essential when designing and implementing solutions strategy for rehabilitation and restoration of degraded land and must become an integral part of mining reality.

Aesthetic and functional reintroduction of sterile dumps involves a set of measures and works made in order to transform the anthropogenic landforms in productive areas, like: agriculture, orchards, forestry, residential, recreational, fishing, sporting, tourist, shopping etc. Their effectiveness should be at least comparable to results prior to commencement of industrial activity.

REFERENCES

[1]. **Bradshaw, A.D.**, *Restoration of mined land-using natural processes*, Ecological Engineering, 1997.

[2]. **Dumitrescu, I.,** *Poluarea mediului,* Ed. Focus, Petroşani, 2002.

[3]. **Dumitrescu, I.,** *Poluarea și protecția mediului*, Ed. Universitas, Petroșani, 2014.

[4]. **Lazăr, Maria, Dumitrescu, I.,** *Impactul antropic asupra mediului,* Editura Universitas, Petroşani, 2006.

[5]. **Nimară, C.**, *Functional and aesthetic reintegration of abandoned coal pits*, Analele Universităţii din Petroşani, Mining Engineering, vol. 11, Petroşani, 2010.

[6]. **Nimară, C., Tofan, G.B.,** *Geomorphological system's vulnerability of the eastern region of Petroşani Depression and generation of critical environments by the coal exploitation activity*, Analele Universităţii din Oradea, Seria Geografie, nr. 2/2015.

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LANDSCAPING SOLUTIONS OF TAILINGS PONDS OF THERMOELECTRIC POWER PLANTS USING VINE PLANTS

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Aurora STANCI **
Sorin-Mihai RADU **

Abstract: *At national level, Romania, face major landscaping problems of areas affected by industrial redevelopment. In case of Thermoelectric Power Plants, most affected large areas of land are occupied by ponds related to Thermoelectric Power Plants. Upon completion of the submission of slag and ashes, ponds should be rearranged and reintroduced in the natural cycle. These activities require significant additional costs. A solution to redevelop tailings ponds could be reusing land for productive purposes. In this paper we propose to study how vine plants are growing on the areas of Thermoelectric Power tailing ponds.*

Keywords: *vine plants, rearranged, slag and ashes*

1. INTRODUCTION

One of the sources of electrical energy is burning solid fuels in Power Plants. Thermal Power Plants, like any existing anthropogenic activity, is a source of environment pollution. Thermal Power Plants pollution affect all environment components, in particular the main elements: water, air and soil.

Currently 29% of electricity produced in Romania is obtained by burning coal in Thermoelectric Power Plants.

By burning coal, Thermal Power Plants, are releasing on chimney gases from combustion, and waste resulting from combustion represented by ash and slag, which are deposited in tailing ponds. Waste in the form of slag and ash of combustion are hydraulically transported as slurry in settling ponds for each thermal power plant. Although tailing ponds are a major source of environmental pollution, the last stage of the process flow, slag and ash storage is necessary and mandatory.

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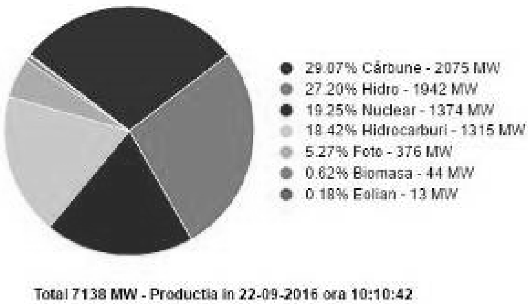

Figure 1. Instant consumption of electricity in Romania

Ponds occupy large areas of land. By making these deposits, the lands on which are located ponds, during the time they are used, they have another destination from baseline.

Upon completion of tailings ponds must be reintroduced in natural circuit. One of the phases of redevelopment is the stabilization of tailing ponds surfaces and prevent currents of air to lead dust on them.

2. THEORETICAL CONSIDERATION

Redevelopment of degraded land from anthropogenic activity is based on a complex of works that relate primarily to redevelopment areas affected. By redevelopment work must be created a new economic potential of the area.

Reconstruction of areas must become an integral part of the anthropogenic project activity. Ponds of the power plants produces on a number of effects on land such as:

- changing the landscape of the region and strong influence and systematic flora and fauna
- reducing agricultural and forestry activity by occupying land devoted to these purposes
- changing hydrological conditions by diverting river works
- changes in technical infrastructure and social
- environmental pollution

There are three types of interventions for environmental recovery of the affected land:

- reconstruction of the landscape as it was before degradation
- seeking a re-use destinations, offer it new forms of land use
- systematization of the affected areas provisional, pending the final decision taken by law enforcement.

The affected areas are within at least one of the types of environmental recovery mentioned above. A solution for the upgrading of the tailing ponds of power stations can be productive recovery. Affected areas can be redeveloped and agricultural crops, vines or fruit trees after restoring topsoil layer from the surface reconstruction of irrigation and drainage system. Also in this category are arrangements for cattle, irrigation or fish farming. In the first case solutions are interventions to recreate an environment suitable for pasture and facilities; second and third case requires appropriate precautions to avoid water pollution. In this paper we intend to present a solution for the upgrading of the tailing ponds of Thermal Power Plans with productive vineyards.

3. VINE

Grapes are adapted to a wide variety of soil types and can be grown successfully on soil not suitable for many other crops. Grapevines are long term plants that can live between 50 to 100 years. Strong, edible fruit likely won’t appear for anywhere from 1-3 years. Before growing wine grapes, must know the chemical and physical properties of the soil.

Soils can have the following problems:

Low organic matter content: soils are naturally low in organic matter, and years of heaving grazing, cropping and ploughing will further degrade them. Low fertility: their natural fertility is not adequate to support a high-yielding, intensive horticultural crop such as grape.

Table 1 Ideal vineyard soil properties.

Soil property	**Ideal range**
pH	6.0–7.0
Exchangeable Na	<7.0%
Exchangeable Ca	65%–75%
Exchangeable K	3%–10%
Bray P	>20 mg/kg
Topsoil organic matter	3%–6%
Total N	0.1%–0.2%
Density	<1.4 g/cm3 in the surface
Free rooting soil depth	0,5m

Almost no natural soils have these characteristics. Nitrogen is the most important nutrient in managing vines. Excess N results in excessive vegetative vigor at the expense of flowers and fruits. Nitrogen deficiency interferes with fermentation time and wine quality. Potassium K is rarely needed in heavier soils but may need attention in lighter soils.

Most important macro elements (required in higher amounts) – Nitrogen (N) – Phosphates (P) – Potassium (K) – Calcium (Ca) – Magnesium (Mg) – Sulfur (S) • Most important micro elements (required in small amounts) – Iron (Fe) – Boron (B) – Manganese (Mn) – Zink (Zn) – Copper (Cu).

In the worst soils, the roots of the grape vines are forced to seek nutrients for sustenance. The lack of water at the right time creates vine stress that force the development of the grapes instead of the leaves and canopies. This helps produce smaller berries with higher juice to skin ratios and naturally brings about lower yields. This creates a wine with more concentration and flavor. The type of soil best suited for grapes used to produce wine effectively regulates the amount of water the vines are able to reach at the right times.

4. CASE STUDY

One of the ponds of the power plants is Caprisoara Valley tailing pond, pond of Thermal Power Plant Paroseni. In order to achieve the proposed study was taken slag and ashes from the tailings pond, and has been planted vine plants.

To study the behavior and way of plant development vines we planted two types of vines: a white variety vine and red - both planted in ash taken from the pond of the Thermal Power Plant Paroseni, and also in soil around them. Due to weather conditions in the Jiu Valley we chose two varieties of vines resistant to low temperatures and freezing. Vine Vitis used is 'Boskoop Glory'.

"Boskoop glory" is a disease resistant, cold-tolerant grape variety from the Netherlands. It is a hybrid between Vitis vinifera and Vitis labrusca. It was developed in the 1950s at Wageningen where American vines had been planted. It is therefore assumed to be a spontaneous crossing of two species from the vineyard. This variety usually ripens fruit in late August or early September and is resistant to fungal diseases and frost. It is a popular table grape in the Netherlands and it is popular among gardeners in the Netherlands, England, Germany and much of Northern Europe. The flavor is very aromatic and juicy.

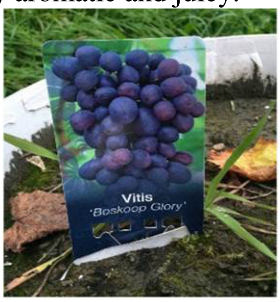

Figure 2. Vitis "Boskoop Glory"

Figure 3. Vitis "Vroege van der Laan"

White vine used is Vitis "Vroege van der Laan"

Vitis 'Vroege van der Laan' is a white grape, yellow, which is particularly suitable for growing outdoors. It belongs to old varieties. The plants are strong and quite resistant to fungal diseases. He is considered one of the best white grape for our outdoor climate. "Vroege van der Laan" always comes at a good production. Grapes ripe in late September-early October. The production is moderate to good. Although grapes are good to eat, they are mainly used for the production of juices and white wines. We used 4 vines of each variety, and were planted in pairs into garden soil in containers and two others has been planted in tailings taken from tailing pond. Plantation was performed in June 2014.

Vitis "Boskoop Glory" planted in soil | Vitis "Boskoop Glory" planted in tailings | Vitis "Vroege van der Laan" planted in soil | Vitis "Vroege van der Laan" planted in tailings

Figure 4. Vine plantation

At the beginning of the growing season of 2015 vines budded without being affected by climatic conditions in the Jiu Valley. This goes to make fruit after the first 12 months after planting.

Vitis "Boskoop Glory" – Grapes from the sample planted in soil | Vitis "Boskoop Glory"- Grapes from the sample planted in taillings | Vitis "Vroege van der Laan" - Grapes from the sample planted in soil | Vitis "Vroege van der Laan" - Grapes from the sample planted in taillings

Figure 5. Vine grapes at 12 months after plantation

Vines grown in tailing container is less developed than in the soil, which is normal due to the lack of nutrients in the soil. It is noted that plants have not been helped with any nutrients. Can be notice differences in both cases the number of leaves on the stem and quantity of grapes. Grape production is half if the vine in ash and slag in comparison with those grown in soil. Production can be increased by adding nutrients.

One solution for productive re-cultivation tailings ponds of Thermal Power Plants could be areas under vine cultivation. Our solution is one with effectiveness and economic investment required for cultivation can be recovered by selling the final products (grapes, grape juice or wine).

5. CONCLUSION

Tailing ponds of the Thermal Power Plants should be rearranged after completing their exploitation. One of the methods of recovery tailings ponds is productive recovery. Tailing ponds can be planted with vines according to the study conducted. Due to lack of nutrients vine is less developed as both the fruit and the leaves, which does not stop the cultivation of these areas with vine plants. To increase productivity plant vineyards, they can be helped with different nutrients and fertilizers.

6. REFERENCES

Goldspink BH, *Fertilisers for Wine Grapes*. WA Dept of Agriculture (1997).

http://www.tuinkrant.com/plantengids/fruit/32618.htm

http://www.wikihow.com/Grow-Grape-Vines

https://en.wikipedia.org/wiki/Boskoop_Glory

https://www.cals.uidaho.edu/edcomm/pdf/CIS/CIS1171.pdf

Nutrient management in Idaho Grape production, Mir-M. Seyedbaghery and others, University of Idaho Extention, CIS 1171, (2009).

Petrilean D. C., et all, *Multicriterial analysis of environmental impacts in thermoelectric power station areas*, Environmental Engineering and Management Journal, Vol.13, No. 6, 1383-1388, (2014).

Ştefănescu L. et all, *Riscuri Asociate Stabilitătii Iazurilor de Decantare din Bazinul Mijlociu al Râului Arieş,* ProEnvironment Nr. 3 598 – 607 (2010).

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RESEARCH ON THE REDUCTION OF COAL SULPHUR CONTENT

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Abstract: *Generally, the coal from Jiu Valley has a sulphur content between 1.3–3.3% or even higher. Taking into account that the coal from the studied area is especially used in energetic purposes (burnt in thermal power plants), the sulphur is regarded as an unwanted element because of the adversity of the oxides released into the environment. Also, considering the toxicity of sulphurous gases over the flora and fauna, this paper analyses, based on original experiments, different methods (desulphurization by flotation, magnetic desulphurization, and bacterial desulphurization) for sulphur content reduction in coal before being used in thermal power plants.*

Keywords: *coal combustion, sulphur, desulphurization*

1. INTRODUCTION

One of the negative aspects of coal combustion is the generation of sulfur dioxide emissions, leading to acid rain occurrence. Therefore, given the increasing demands in environmental protection, there is needed a more advanced coal desulphurization in the pre-combustion phase.

The desulphurization of the coal used in the burning process in thermal power plants has the following advantages: eliminates investment needed to achieve gas desulphurization equipment, reduces the polluting elements of ash, slag and gas.

Desulfurization of coal can be carried out by flotation, gravitational procedures, magnetic separation or using bacteria.

The coal is a macromolecular compound with a very complex structure, the composition of which includes: C, H, O, N, S.

The element sulfur is found in coal in the following forms:

- Sulphate sulfur;
- Sulfur sulphide (pyrite and / or Marcasite);
- Organic sulfur.

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Sulfur sulfate - is a minor element in the sulfur balance in coal, rarely going above 0.2%. The presence of sulphate sulfur is due to the oxidation of pyrite with the oxygen from atmosphere or water, leading to ferrous sulphate ($FeSO_4$). Sulfur sulfate is found in the form of $CaSO_4$, being brought by percolation water.

Sulphide sulfur - can be present as pyrite and marcasite. In coal, the pyritic sulfur is present in different amounts and forms, from very fine microscopic particles released into the mass of coal, up to thick granules of few millimeters. (figures 1, 2).

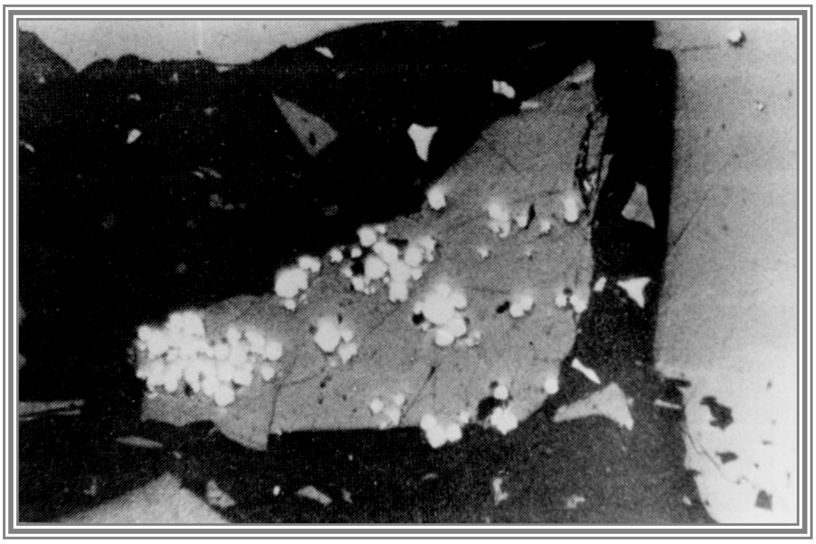

Fig.1. Finely disseminated pyrite into the coal mass

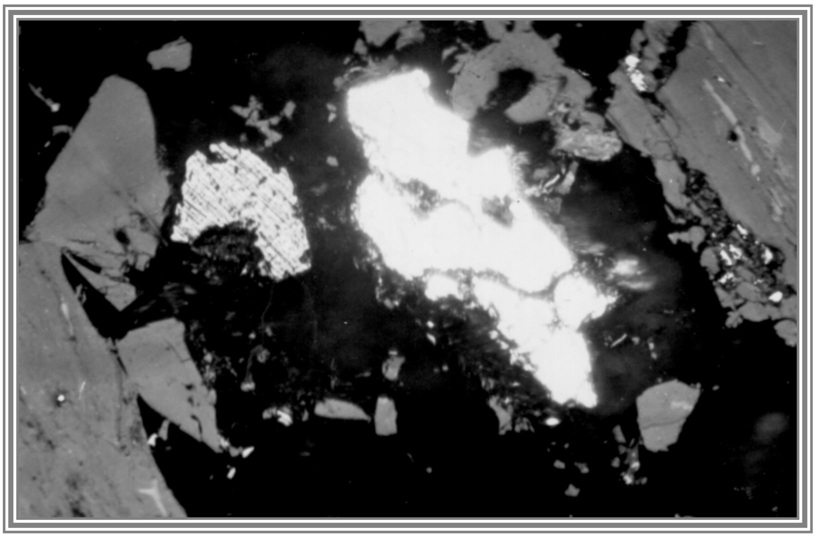

Fig.2. Pyrite in the form of thick granules

The vast majority of pyrite in the Jiu Valley coal is finely disseminated into the coal mass, generally having sizes from 0.1 to 0.25mm.

Organic sulfur - is found in coal in three forms:

- Sulfur in the form of -SH or H-S-S-H in a concentration of 2%, which by oxidation forms HSO_3;
- Sulfur in the form of C = S, which after oxidation is removed in the form of SO_2;
- Sulfur in an undefined form, highly resistant to chemicals reagents.

Sulfur is alongside other elements, an unwanted element in coal because by burning coal in power plants results a set of agents, one more harmful than the other, leading to a mechanical and a chemical pollution of the environment:

- Mechanical pollution – represented by the particulates entrained in chimneys;
- Chemical pollution - caused by the action of chemicals from the combustion of coal.

Chemicals resulting from burning coal have a complex impact on all environmental factors in their surrounding area (atmosphere, soil, water). Air pollution with SO_2 is very harmful to the human body. A concentration of 20 ppm SO_2 produces coughing and irritates the eyes, this compound also greatly affecting vegetation. On the wet leaves, sulfur dioxide dissolves forming sulfuric acid (H_2SO_3) which passes through oxidation in sulfuric acid (H_2SO_4) which is a harmful agent. This occurs especially in winter, so the conifers suffer primarily because they keep their leaves in winter.

Considering that by burning coal very harmful chemicals for flora and fauna are released, there it is required a purification of coal before burning, to reduce the sulfur content. This can be done either by traditional methods (gravitational concentration, flotation, and heavy media) or by chemical or biological methods.

1. EXPERIMENTAL PART

The paper presents several methods tested in laboratory and pilot phase for reducing sulfur from coal before subjected to combustion, through various methods.

2.1. Coal desulphurization by flotation

Flotation is a physical-chemical process which is based on the difference between superficial properties of the surface of particles of coal and sterile. This method is applied to fine grain classes, resulting in the reduction of pyritic sulfur content for class + 0,074 mm size up to 90% and class -0,074 mm size to 30%. (Krausz S., Sarbu R., Badulescu C., s.a, 2008).

The efficiency of the flotation process is influenced by the following parameters:

- The granulometry of the material, in coal the optimal class is from 1.17 to 0.30 mm;
- The degree of coal oxidation influences the surface characteristics of particles;
- The characteristics of the water (particularly pH), the optimum pH of coal is 6 -7.5;
- Characteristics of reagents,
- Flotation equipment used.

2.2. Research of desulphurization by separation processes in hydrogravitational and hydrocentrifugal fields

Hydrogravitational concentration processes are among the oldest concentration processes in both ore and coal. (Tomus N., Cismasiu M.C., Deak E.S, 2014)

Hydrogravitational separation is achieved easier when between the mineral species there is a difference of specific weight and when they fit into a close range granulometry, plus the difference in the form of granules.

Some examples of devices that use the water current concentration are: concentration tables, Reichart cones, and among the devices that are used in centrifugal field to concentrate we can mention hydrocyclonage, spirals, Knelson, Falcon or Mozley multigravitational concentrators.

The National Institute for Research and Development for Rare and Radioactive Minerals (NIRDRRM) Bucharest and the University of Petrosani performed experimental research using the Mozley concentrator and the concentration tables, on coal from different mining fields from Jiu Valley. Following the laboratory research several conclusions can be drawn:

- weight extraction of the mass concentrate varies between 1.76 and 7.14% depending on the mining field from which the coal originates;
- the content of sulfur in the mass concentrate is not much different from that in the feed, is a maximum of 2.88% for coal coming from E.M.Petrila, which means that a small amount of sulfur less concentrated in the mass concentrate; (figure 3)
- sulfur extraction in mass concentrate was calculated based on weight extraction and the ratio of sulfur in the concentrate and in the feed, obtaining a value below 10% for all the sorts of coal analyzed; (there were exceptions in Petrila and Lonea areas with the values 11,34% and 12.21%);
- as a general conclusion it can be said that coal desulfurization using Gemeni concentration table for less than 1 mm grain size coal is not justified given the very low sulfur extraction in the concentrate;

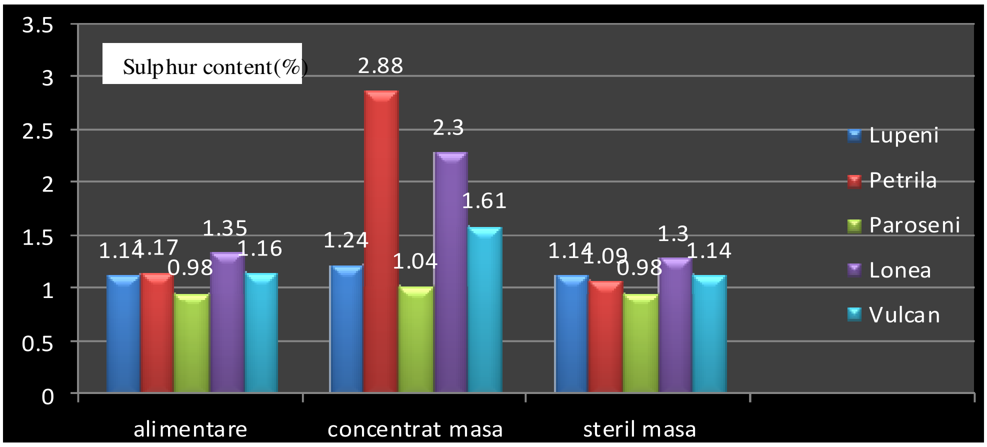

Fig.3 Distribution of sulfur content in products and mining fields-mass concentration

Desulfurization tests using Mozley concentrator, which is a device that combines the principle of the centrifugal field with the one of the hydrogravitational concentration led to the following conclusions:

-weight extraction of the concentrate is high enough (between 8 and 28%) for the coal coming from Jiu Valley Basin, but an inverse concentration of the sulfur is produced, this being explained by the fact that within the apparatus concentrate there were coarse size coal particles with lower sulfur content;

-based on the obtained results there can be stated that not even the Mozley concentrator gave the expected results for coal desulphurization (figure 4.)

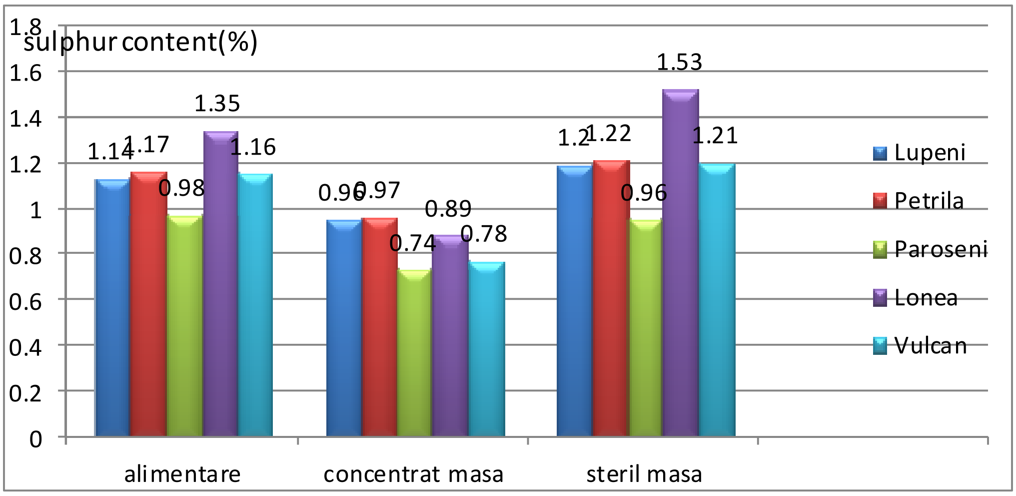

Fig.4. Distribution of sulfur content in products and mining fields-Mozley concentrator

2.3. Electrical desulphurization of coal

Electrical separation tests led to the following conclusions:

- separation is not achieved on conductive or non-conductive products with a significant sulfur content compared with the feed;
- during the electric field separation a division of the feed material in two fractions is obtained; the coarse fraction reaching in the conductive product due to centrifugal force that prevail in comparison with the and the fine fraction reaching in the non-conductive product because of electrical force;
- in the non-conductive product which has a relatively low weight extraction 8-15% and 10-17% sulfur extraction, there are distributed especially fine minerals from the grinding of sterile rocks in coal
- in addition to poor results in terms of reducing the sulfur content, if one takes into account that the separation in electric field requires the heating of the material to a temperature of at least 850C the application of this process is not justified.

2.4. Magnetic desulphurization of coal

Magnetic separation was used to purify the small size coal particles. This process is based on the difference between the magnetic properties of coals and the associated minerals. Tests on magnetic concentration were carried out at different intensities of magnetic field. (Murray H.,1997)

After applying desulfurization by means of magnetic separation, the following conclusions can be drawn:

- For the process of magnetic separation to be applied, the tested material is necessary to be grinded down to 1 mm and an average size of 0.3 mm
- the weight extraction of magnetic product is between 6 and 26% (the mining areas with high weight extraction are Lonea and Petrila);
- the sulfur content in the magnetic product is as follows: 11.48% at Lupeni; 8.34% at Paroşeni, 6.4% at Vulcan; 3.09% at Petrila; 5.85% at Lonea;
- the weight extraction of the non-magnetic product is between 76 and 94% (higher in the western part of the Jiu Valley and lower in the eastern part);
- the sulfur content in the non-magnetic product is as follows: Lupeni-0,48%S; Paroşeni- 0,51 %S;Vulcan-0,57% S; Petrila-1,14%S; Lonea-1,12%S;
- in the non-magnetic product there remained between 40 and 54% of the sulfur existing in the original coal, which means that sulfur is not bound only to pyrite, but also to non- magnetic sulfates;
- the organic sulfur which is chemically bound to the carbon in the coal can be extracted only by chemical or biochemical processes, after the breaking of chemical bonds;

- between the iron and sulfur content of the magnetic products there is not necessarily a dependence because iron may be present in coal also in the form of oxides or silicates not only in the form of pyrite and marcasite.

It appears that much of the mineral impurities contained in coal are paramagnetic and may be removed by magnetic separation after advanced grinding to achieve the release of the mineral constituent species.

For a more efficient desulfurization, an increase in the magnetic properties of pyrite from coal is required using various methods. One such method is the selective wetting of the constituents with a water-based ferrofluid. The component wetted by ferrofluid and thus reported as magnetic product is, in this case, the mineral (pyrite, clay, silica). Magnetic susceptibility of coal will not be affected and they will form the non-magnetic fraction. To separate the "magnetized" component a high gradient magnetic separator (HGMS) was used, obtaining the following:

- the content of inorganic constituents was reduced from 17% to 5%;
- the sulfur content of a raw coal was reduced from 1.9% to 0.7%;
- the amount of SO_2 emitted into the atmosphere by the desulphurised coal combustion was three times lower than that of raw coal combustion.

2.5. Bacterial desulfurization of coal

The Jiu Valley coal is characterized by a great diversity of total sulfur, the mineral and organic sulfur ratio being 1:1. The sulfur content of coal is characterized by values ranging between 1.3 - 2.6% for the eastern part of the coal basin and from 2.4 to 3.3% for the western part.

The used mechanical processing methods have not given favorable results in reducing sulfur content due to very fine disseminated pyrite in the coal organic mass

In the first part of the research, microbiological and chemical analyzes of water samples collected from Lupeni mine were performed. During these analyses a wide range of culture media were used for the following:

- to highlight the chemoautotrophic mesophilic sulfur and iron oxidizing bacteria (genus *Thiobacillus*), the sulfate-reducing bacteria, the ferobacteria and heterotrophic aerobic bacteria
- to know the microflora of mine water
- to isolate chemoautotrophic sulfur and iron oxidizing bacteria.

The following chemoautotrophic sulfur and iron oxidizing bacteria species were found after the determination: *T.thiooxidans, T.thioparus, T.neapolitanus, T.ferrooxidans, T.denitrificans, T.novellus.*

The coal used for the next step of the research came from Lupeni mine, having a 2.81% total sulphur content. After the research the following can be concluded:

- Lupeni coal, due to its high content of carbonates do not provide the optimum conditions (pH of the culture medium tends to become neutral) for the development of bacteria belonging to the genus Thiobacillus, the sulfur was removed from the charcoal only in a proportion of 5-25 %;

- the success of bacterial desulfurization of coal depends on the composition, structure and dispersion of the sterile in coal, especially of the alkaline one. The reaction of coal sterile (which has the ability to fix the sulfuric acid) and sulfuric acid resulting from the action of bacteria, leads to the formation of alkaline sulfates, that are not consumed by bacteria;
- to perform desulphurization is necessary to create a culture medium for bacteria with a 2.5 pH by addition of hydrochloric acid;
- the duration of the desulphurization process is at least six days;
- by biological desulphurisation there can be removed approx. 20% of total sulfur, and can be locked in the form of a sulfate a percentage of 60% of the sulphide content;
- bacterial desulfurization capacity gradually decreases with increasing the size of coal particles;
- desorption of desulphurisation products is made through washing with warm water;

For the desulfurization of the hard coal from Lupeni mine by bacterial leaching means, the following were used:

- A 5 liter air-lift bioreactor of the Deutsche Montan Technology Research Institute in Essen
- 9K culture medium without $FeSO_4$
- *Thiobacillus ferooxidans* from the Czechoslovak Collection of Microorganisms in Brno
- The concentration of bacteria introduced into the process was of 10^9/1 ml.
- The pH of the solution was maintained between 1.8-2.0
- The duration of bacterial leaching was 28 days
- The temperature was 28-30ºC.

Petrographic analysis carried out at the Institute of Geotechnics CAV in Prague revealed that coal from the Lupeni mine contains 84.4% vitrinite, 13.8% liptinite and 1.4% inertinite. The mineralogical composition consists of pyrite, clay minerals, particularly carbargilite. Pyrite is present in spheroidal form, the granules located in the mass of mineral coal. (P.Fecko, 2007).

After the bacterial leaching using *Thiobacillus ferooxidans* for one month, the total sulfur content was reduced from 2.81% to 1.79%, showing a degree of desulphurisation of 36.30%, pyritic sulfur being mainly reduced (92.96%) (Table 1).

Table 1. **Reducing the sulfur content of coal from the Lupeni mine, Romania, after bacterial leaching**

Sulphur content	Before leaching (%)	After leaching (%)	Desulphurization degree (%)
Total sulphur	2.81	1.79	36.3
Pyritic sulphur	0.71	0.05	92.96
Organic sulphur	4.03	1.59	60.55
Sulphur sulphate	0,15	0,07	53,33

Figures 3 and 4 present the image of the pyrite particle after a week and three weeks of leaching.

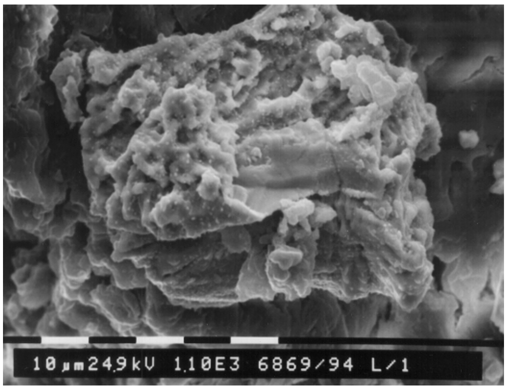

Fig.3. Pyrite after a week of bacterial leaching

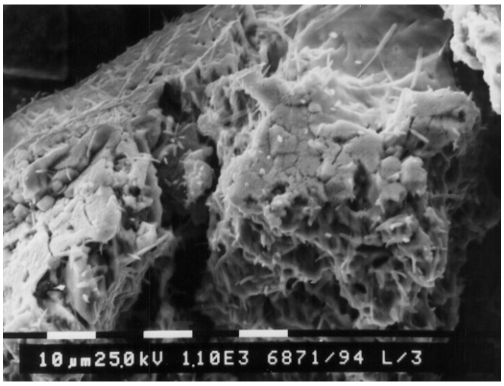

Fig.4. Pyrite after bacterial leaching

2. CONCLUSIONS

It can be said that coal desulfurization using Gemeni concentration table for less than 1 mm grain size coal is not justified given the very low sulfur extraction in the concentrate;

Researches using Mozley concentrator that combines field hydrocentrifugal at hydrogravitational revealed that even with this type of device cannot achieve a significant reduction of sulfur content in the desulphurized coal.

During the electric field separation a division of the feed material in two fractions is obtained; the coarse fraction reaching in the conductive product due to centrifugal force and the fine fraction reaching in the non-conductive product because of electrical force.

Desulfurization by flotation can be applied to fine grain classes, resulting in the + 0,074mm class size a pyritic sulfur content of 90%;

Worth considering the results of the processes for desulfurization of coal in the magnetic field performed when a reduction of the sulfur content in coal to 50% is obtained.

The magnetic coal desulphurization applies to small size particles, with a reduction in the concentration of mineral components from 17% to 5% and the sulfur content from 1.9% to 0.7%.

By biological desulphurization approximately 20% of total sulfur can be removed.

After the bacterial leaching using *Thiobacillus ferooxidans* for one month, the total sulfur content was reduced from 2.81% to 1.79%, showing a degree of desulphurisation of 36.30%, pyritic sulfur being mainly reduced (92.96%).

REFERENCES

[1.] **Abel, W.T**. – *Removing Pyrite from Coal dry-Separation Methods*, Bureau of Mines, USA, 1973;
[2.] **Badulescu C., Ionescu C., Moldovan C**. - *Desulfurarea magnetică si bacteriană a cărbunilor,* Revista Minelor, Nr.2/2009, pag.9, 2009;
[3.] **Badulescu C**.- *Biotehnologii in protectia mediului*, Ed Universitas, Petrosani, 2010
[4.] **Belly R.T., T.D.Brock –** *Ecology of iron-oxidizing bacteria in pyritic materials associated with coal.* Journal of Bacteriology, 117 (2), p.726-732,1974;
[5.] **Deurbrouck,A.W, Jacobson, P.S.** – *Coal Cleaning* , State of the Art; Coal Utilization Symposium- SO_2 Emission Control, National Coal Conference, Louisville, 1994;
[6.] **Fečko P**.– *BIOTECHNOLOGY - technologies of 21 century.* Institute of Environmental Engineering Mining University of Ostrava, Czech Republic, 2007;
[7.] **Fecko P**.– *Bacterial Desulphurization of Coal from Lupeni in Romania*, Proceedings of the 7-th International Mineral Processing Symposium, Istambul, pg.361-366, 1998;
[8.] **Kecko P**- *Biotechnology –technologies of 21 century,* Institute of Enviromânmental Engineering Mining University of Ostrava, Czech Republic, , 2007
[9.] **Krausz S., Sarbu R., Badulescu C., s.a.** - *Tehnologie curată pentru desulfurarea cărbunilor în scopul reducerii emisiilor de SO_2 la arderea lor în termocentrale,* Contract de cercetare, 2005-2008;
[10.] **Murray H.H** – *High Intensity Magnetic Cleaning of Bituminous Coal* , Second Symposium on Coal Preparation, Loisville, Kentucky, 1976;
[11.] **Malik, A., Dastidar, M.G., Roychoudhury, P.K**. – *Factors limiting bacterial iron oxidation in biodesulphurization system*, International Journal of Mineral Processing, vol.73, No.1, 2004.
[12.] **Tomus N., Cismasiu M.C., Deak E.S** -*Tehnologie curata pentru desulfurarea carbunilor în scopul reducerii bioxidului de sulf la arderea în termocentrale*, Buletin CENTIREM, nr.8/2014, pag.60, 2014;
[13.] **Zarnea G** – *Tratat de Microbiologie Generală,* ED.Academiei, vol. II, p.289-301,1984;
[14.] **Wierzchovski K. Sablik .J**., *Extragerea piritei din concentratele de flotaţie a cărbunelui, funcţie de dimensiunea particulelor de pirită.* Coal international.Mineralurgy, nr.35, 1998 p.175, 2000.

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RESEARCH CONCERNING THE POSSIBILITY OF WASTE DUMPS PROCESSING IN THE JIU VALLEY – E.M.LUPENI CASE STUDY

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ADRIANA DONEA CIOCAN **

Abstract: *This paper presents the recovery possibilities of mass combustible and provides the necessary data in order to decide whether investments towards energy potentials they have such deposits. Based on extensive laboratory research papers, could determine the opportunity of capitalization the carbonaceous mass through the development of technological flows possible to apply to the waste dumps Jiu Valley. By processing waste dumps can be made and environmental rehabilitation works, which can be supported with funds from environmental protection.*

Key words: *coal waste dumps, coal processing, technological flow*

1. INTRODUCTION

The paper presents three technological variants of recovery wastes dumps from E.M.Lupeni.

1.Takeover the waste dump, branch II with mechanized means, loading and transport at the plant for processing, mixed with raw coal as feeding plant; by arranging a loading point on the body dump (or angular station) transportation is made easier by a funicular railway after emptying the daily production branch wastes dump III. Be arranged in this case and point of collection and transport band circuit of coal received from mine. From a technological standpoint we have studied the effect of reintroducing this material in processing circuits, which require changes in flow, taking into account the conclusions of waste processing from branch II Lupeni.

2. Designing a mobile station for processing the wastes dump, final wastes deposition after ecological criteria that favor environmental rehabilitation. The concentrate is loaded and transported by car to a delivery point within the plant. An alternative transportation is to use buckets to return the branch empty with a loading point at angular station and download the material directly, in wagons, on a line

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designated for that purpose and which passes under the main branch of the funicular sterile Lupeni.

3. Fitting to the angle station area of a facility ranking – manual assortment coal and crushing at 40 mm. The final waste (+ 40 mm) is used to create a dam core for receipt the waste resulted from processing the class (- 40 mm) in a separator Rheo with heavy media in the clay-based. The water needed to be taken from reservoirs upstream of the discharge branches.

Choosing a technological flow and design it for concentrating the waste with high ash content, must carried out a lot of testing, laboratory and pilot phase, a wider range of methods of gravitational and centrifugal concentration field. Based on the results of calculations can be made probabilistic outcomes, taking into account the index of imperfection of each type of machine. At the same time we can estimate more accurately the investment opportunity and processing option on mobile station or fixed. Based on the intensity of exploitation options can be set: capacity of the plant, the working and the most appropriate technological flow.

Knowing precisely the items listed correlated with the findings of the current study can form the basis for a project operating branch dump no. II Lupeni, with expansion in favorable areas of the branch I and III branch perspective.

The success of the experiment to exploit the mass body dump fuel first Lupeni, may be a reason for the extension and improvement of technology at other coal waste dumps in the Jiu Valley.

2. RESEARCH CONCERNING THE POSSIBILITY OF CAPITALIZATION THE COMBUSTIBLE MASS FROM THE E.M.LUPENI WASTE DUMPS

The recovery of combustible material must be related to the use, at least partially, new tailings from the process for the production of construction materials, possibly extraction of useful mineral components.

The capitalization of secondary energy resources present in the bulk deposits formed over time in each processing plant requires a detailed knowledge of the areas with higher content of fuel mass, to be subject to extraction and processing.

In this work must be carried sampling and analysis of mineralogical and combustible components. Also take into consideration the possibility of access to machinery for the extraction and transport of the concentrate, as most dumps are located on rough roads and existing roads become impassable under a higher level of precipitation.

Final waste storage will raise specific issues due to high mineral content and clay material than are currently in the dumps. In addition there are much finer grains because wet processing will promote further degradation of the mineral material component. Purchase or local design and manufacture of mobile mining and processing plant tailings involves investments that are required to be identified sources of funding especially in the area of environmental rehabilitation facilities.

Based on a serious analysis of the dressability characteristics on granulometric classes processed routinely at Preparation Lupeni, have outlined the following two technological options that offer the possibility of increasing the recovery of clean coal products obtained.

1. Technological variant I, of coal waste processing on granulometric classes: 40-80; 0.5-40 and -0.5 mm;
2. Technological variant II of waste coal processing on granulometric classes: 0.5-40 and -0.5 mm.

Theoretical foundations of 0.5-40 mm size fraction possibility to be processed by jigging and characteristics of the material treated in these options are presented below. To determine the limits of particle size of the material which can be treated in the jigging machine Wedag Batac, based on density analysis of raw coal was passed to determine the maximum diameter of coal from feeding machine. For this purpose is calculated simpthotic ranking coefficient. This coefficient for the N-R domain, according to Richards's theory is(:R.Sarbu, 1993)

$$q = \sqrt{e_{st}} \qquad (1)$$

Where: e_{st} - coefficient of simpthoticity in fall conditions hampered;

$$e_{st} = \frac{\delta_2 - \rho_a}{\delta_1 - \rho_a} = \frac{d_1}{d_2} \qquad (2)$$

Where: δ_1 - the density of easy product
- δ_2 – density of heavy product
- ρ_a – the bulk density of material bed in jigg compartment
- d_1 – the size of easy range
- d_2 – the size of heavy range

$$\rho_a = (1 - \varepsilon)\,\delta_m + \varepsilon\Delta = (1 - 0{,}37)\,.\,1{,}744 + 037\,.\,1 = 1{,}45\ kg/dm^3 \qquad (3)$$

Where: ε - raising coefficient of material bed
- δ_m – average density of coal from the material bed
- Δ - water density

$$\delta_m = \frac{\sum v_i \cdot \delta_i}{\sum v_i} = \frac{39.2 \cdot 1960 + 46.6 \cdot 1744}{85.4} = 1699\,kg/dm^3 \qquad (4)$$

Where: v_i- quantities percent of densimetric classes with δ_i density

δ_0 – the bulk density, which for small coal is: 0,9 – 1,1 kg/dm^3.

The experimental trial on coal sample indicated a value of 1,16 kg/dm^3.

$$\varepsilon = 1\frac{\delta_0}{\delta_m} = 1\frac{1160}{1699} = 0.32 \tag{5}$$

$$\varepsilon_{st} = \frac{\delta_2 - \rho_a}{\delta_1 - \rho_a} = \frac{2.090 - 1.5}{1.865 - 1.5} = 1.61 \tag{6}$$

$$q = \sqrt{e_{st}} = \sqrt{1,61} = 1,26 \tag{7}$$

The simpthotic ranking coefficient is the ratio of two row limit velocities of particles fall

$$q = \frac{v_{01}}{v_{02}} \tag{8}$$

Where: v_{01}- limit velocity fall of the biggest particles from the easy product;
v_{02} – limit velocity fall of the smallest particle from the heavy product.

The limit velocity fall is calculated with the next relation:

$$v_{01} = k_{N-R} \cdot \theta \sqrt{\frac{\delta - \Delta}{\Delta}} \tag{9}$$

Where θ is impeding factor and K_{N-R} is Newton-Rittinger constantr

$$\theta = \frac{(\rho - \rho_A)\cdot \eta}{(\rho - \Delta)\cdot \eta_{st}} = 0.24 \tag{10}$$

Where η_{st} is viscosity in impeding conditions

$$\eta_{st} = (1 + 2,5 \,.\, c + 7,35\, c^2 + 16,2 \,.\, c^3) = 1,33 \,.10^{-3}\, Ns/m^2 \tag{11}$$

$$v_{01} = k_{N-R} \cdot \theta \sqrt{d_2 \frac{\delta_2 - \Delta}{\Delta}} = 2.73 \cdot 0.24 \sqrt{0.5 \cdot 10^{-3}\, \frac{2090 - 1000}{1000}} = 0.015 m/s \tag{12}$$

$$v_{01} = v_{02} \,.\, q = 0,015 \,.\, 1,26 = 0,019 \text{ m/s} \tag{13}$$

Explaining v_{01}, we get off the size of the biggest easy particle, d_1.

$$d_1 = \frac{v_{01}{}^2 \cdot \Delta}{\theta^2 \cdot k_{N-R}{}^2 \cdot (\delta_1 - \Delta)} = 0.040m \tag{14}$$

It follows from the above results that the limit dimensions of the material to be processed by jigging, are 0.5 and 40 mm. To achieve class 0,5 - 40 mm raw material should be placed on a screen mesh size θ = 48 mm, and must be made before jigging a slurry removal on a curved screen with holes spaced at θ = 1 mm.

Taking into account that the beneficiary is required technological concentrate 0-40mm, we find that jigging machine can process material in class size from 0.5 to 40 mm, maximum size being smaller than the size limit that can be used to jigging process. Therefore, in the following we calculate the circuit breaker to reduce the size of the coal supplied below 40mm.

Crushing scheme that is appropriate is an open circuit breaker with elimination + 40 mm from the crusher feeding. Given the standard of ranking areas and that the crossing get a small amount of pellets difficult for classification was adopted for the area classifying θ = 48mm yields ranking with an efficiency η = 80 %. We propose that the refusal sieve material to be feeding a hammer crusher.

3. TECHNOLOGICAL VARIATNS OF WASTE COAL PROCESSING

The technological flow I, for (40-80), (0.5-40) and (-0.5)mm classes processing is presented in figure 1.

The technology consists of:

- Classification of material from feeding at 80 mm, followed by manual assortment of + 80 mm material with elimination of a waste dump (5%), with 78-80% ash content. This operation is justified because the ash content of class +80 mm is high (about 74-76%), and must avoid this material from plant feeding. This would entail a decrease of feeding to preparation, a reduction in losses in waste and clean coal automatically increase selectivity and the efficiency of coal plant.
- To achieve this required a number of modifications that can be made, as follows: the present manual assortment conveyors 28A and 28 becomes only one conveyor by a higher and an elongation with 2.5 m; manual assortment conveyor 29, must be elongated with 5 m; waste conveyor 214, must be elongated with 15 m.
- The crushed product together with -80 mm material is classified at 48 mm; + 40 mm go to the jigging process in OM-18 machine. According to the probable calculation results, the rough coal has an ash content of approximately 70% and after processing, can obtain a concentrate (7.4% recovery) with 33.6% ash content for household consumption; the waste (24.1% recovery) has 81.75 ash content.
- The material under 40 mm pass by curves screens (0.5mm) and represents 63.5% from total feeding; the material over 0.5 mm, representing 49.5%, with 50.4%

ash content is concentrated by jigging and obtains two products: a combustible coal with 48.3% ash content and a waste with 82.3% ash content.

- If the jigging machine feeding has un ash content up to 53%, than the concentration process is unnecessary; this product can be valorized as energetic product after water draining.
- The slurry (-0.5mm) is concentrated by flotation and represents 14% from total feeding with 56% ash content. At flotation we can use as collector a new product (oil residue), chipper with 25% than diesel, usually used. As froth agent we can use AF. The flotation results are higher with 15% than usual flotation reagents regime. The flotation concentrate has 34% ash content and the tailings, 76%.

The technological flow II, for (0.5-40) and (-0.5) mm classes processing is shown in figure 3.

Achieving this variant started on the express request of the beneficiaries of the energy sector to achieve heightened energy coal to grain size of 40 mm.
From global density analysis from material under 40 mm, results an average ash content of 58.03%. The H-R curves are presented in figure 2.

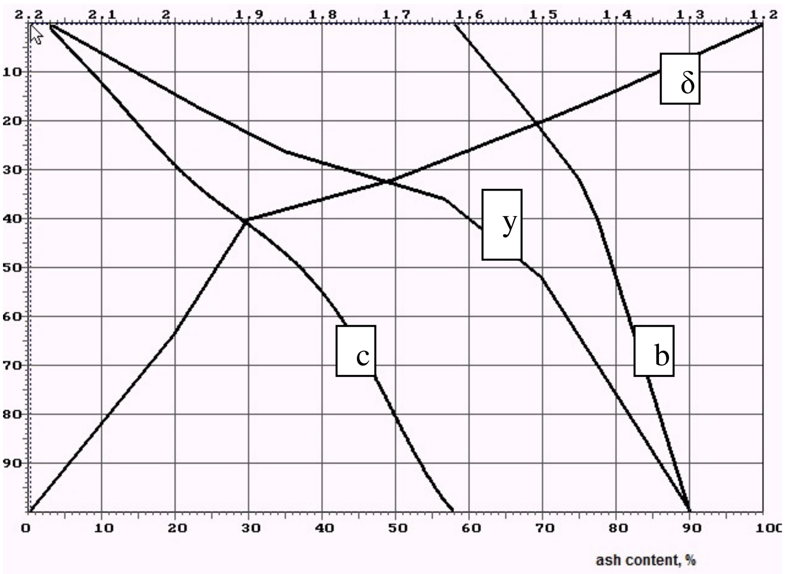

Fig. 2 H-R curves from Lupeni coal, class(0-40) mm

Based on the results of this analysis was passed to the calculation of probable results of concentration on Wedag jigging machine at imperfection index around 0.15. We performed calculations of probabilistic outcomes for different density separation, establishing that the most favorable situation is encountered for Separation density of 2.4 kg/dm^3. In these circumstances the ash of energetic coal is 52.1%, calorific power of 3.300 kcal / kg, an overall recovery of 92%.

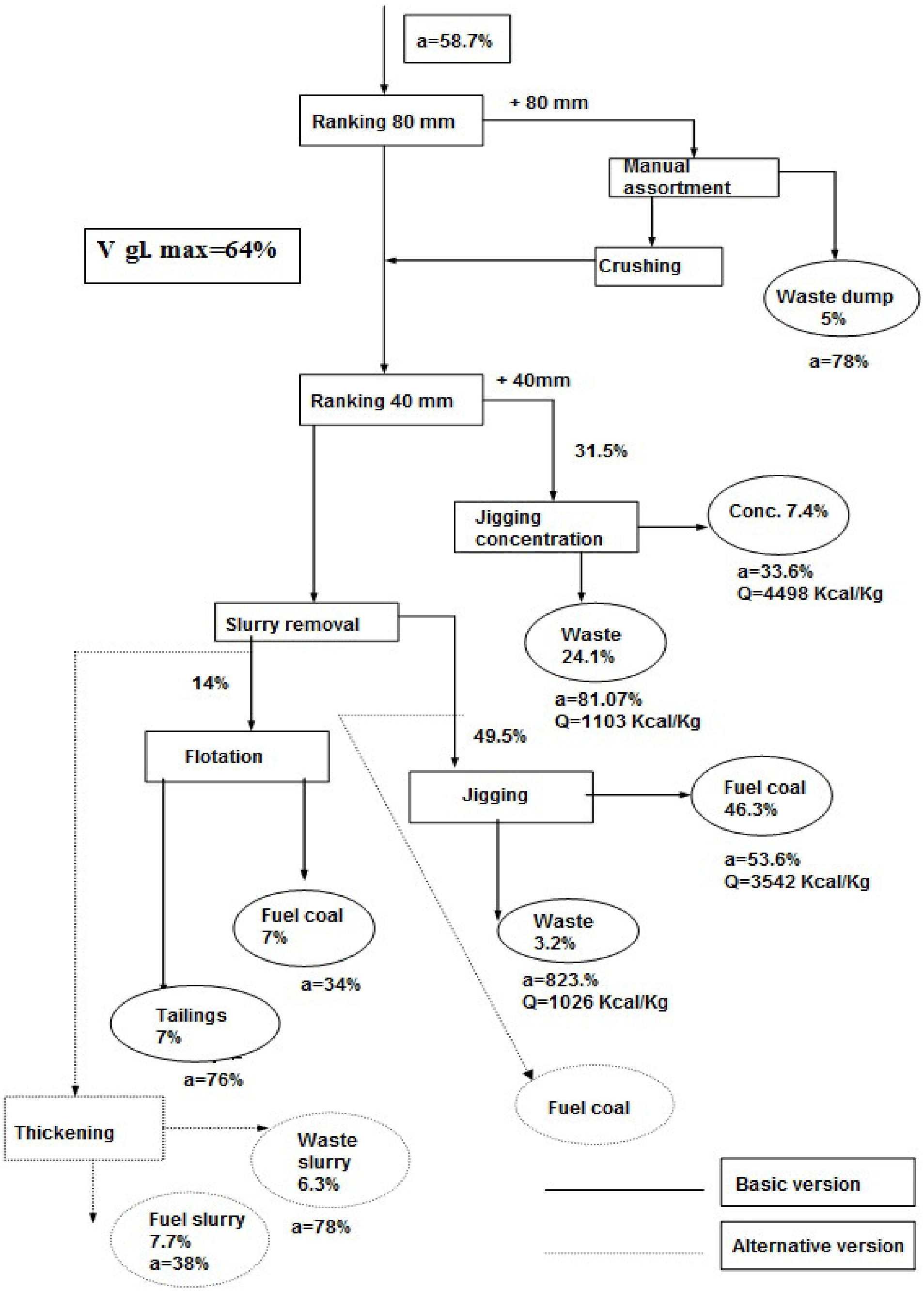

Fig. 1 Technological flow I, for (40-80), (0.5-40) and (-0.5) mm classes processing

The first operations, classification at 80 mm, manual assortment and + 80 mm crushing are the same as to the technological flow I.

Because the slurry from the technological flow is higher, is necessary a thickening operation. The thick material has 79% ash content and after filtration we obtain waste slurry cakes. By jigging process we obtain 18.6% waste with 79.6% ash content and an energetic product with 51.4% ash content (60.4% recovery) and Q=3359 Kcal/Kg.

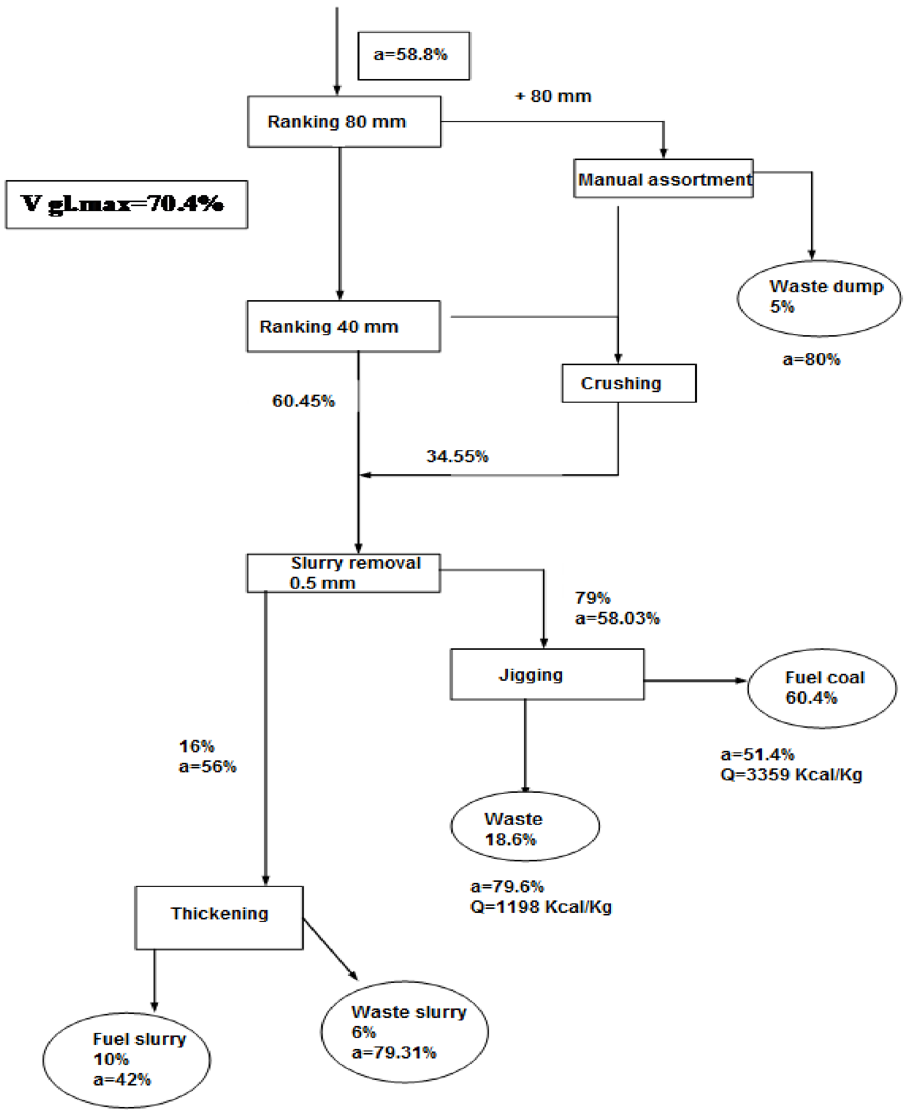

Fig. 3 Technological flow I, for (0.5-40) and (-0.5) mm classes processing

The most rapidly adopted and predictable costs lowest consists of building at angular station a installation of ranking – manual assortment coal and crushing at 40 mm. The final waste (+ 40 mm) can be used to a base dam from processing tailings deposit - class - 40 mm. Concentration can be made in Rheo dense medium separator. The water needed to be taken from reservoirs upstream of the discharge branches (fig. 4)

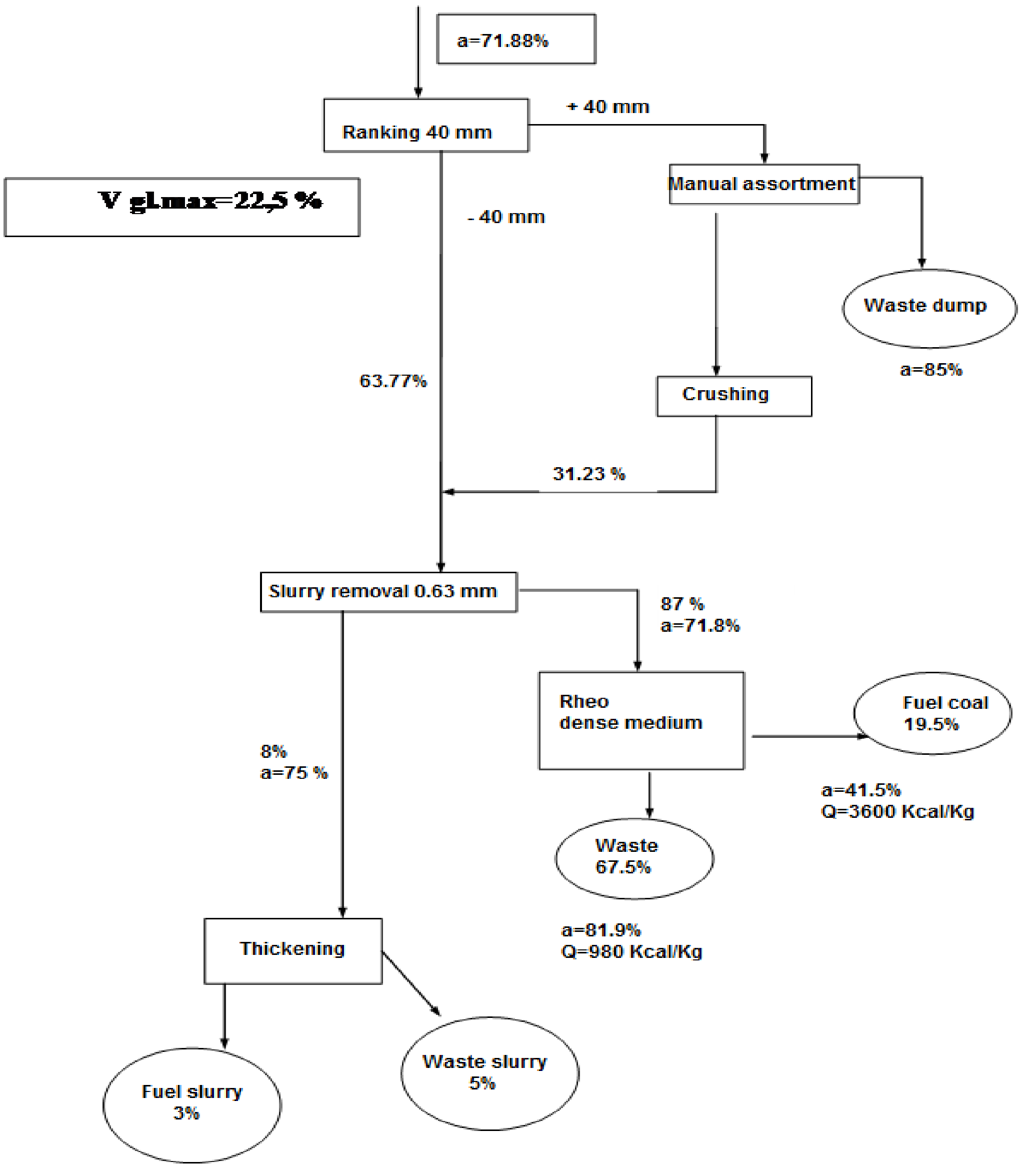

Fig. 4 Technological flow III – fixe instalation to the angular station

4.CONCLUSIONS AND PROPOSALS

The presence of a significant combustible potential in the waste mass justify investing the possibilities of recovery and capitalization in energetic industry with current production.

The capitalization of secondary energy resources present in the bulk deposits formed over time in each processing plant requires a detailed knowledge of the areas with higher content of fuel mass, to be subject to extraction and processing.

The density analysis of coal waste of three coal processing plants (Petrila, Coroeşti, Lupeni) from the Jiu Valley point out that the greatest coal recoveries can be obtained from the waste dump Lupeni.

The most rapidly adopted and predictable costs lowest consists of building at angular station a installation of ranking – manual assortment coal and crushing at 40 mm. The final waste (+ 40 mm) can be used to a base dam from processing tailings deposit - class - 40 mm. Concentration can be made in Rheo dense medium separator. The water needed to be taken from reservoirs upstream of the discharge branches.

Final waste storage will raise specific issues due to high mineral content and clay material than are currently in the dumps. In addition there are much finer grains because wet processing will promote further degradation of the mineral material component. Purchase or local design and manufacture of mobile mining and processing plant tailings involves investments that are required to be identified sources of funding especially in the area of environmental rehabilitation facilities.

The recovery of combustible material must be related to the use, at least partially, new tailings from the process for the production of construction materials, possibly extraction of useful mineral components.

Estimated earnings, at this stage of research, we can consider acceptable for an investment in the area and also by processing tailings can be made and work environmental rehabilitation, which can be supported with environmental protection fund. The conclusions of the current study can form the basis for a project operating branch dump no. II Lupeni and successful experiment to exploit the mass body dump may be a reason for the extension and improvement of technology at other coal dumps in the Jiu Valley.

REFERENCES

[1]. **Bican, P. ş.a.** – *Consideraţii privind reabilitarea ecologică şi sistemul de management a zonelor afectate de exploatările miniere din Valea Jiului*, Sesiune de comunicări ştiinţifice – Universitatea din Petroşani.

[2]. **R.Sarbu, M.Georgescu, C.Badulescu** – *Surse de poluare si impactul lor asupra mediului in bazinul carbonifer Valea Jiului,* Revista de ecologie industriala, nr.4-5/1998, pag.37.

[3]. **C.Badulescu, R.Sarbu -** *Impactul activitatii de procesare a carbunelui din Valea Jiului asupra mediului,* Buletinul AGIR, NR.3/2006, pag.76.

[4]. C.Badulescu - *Posibilitati de valorificare integrala a slamului steril rezultat in urma procesarii carbunilor din Valea Jiului in vederea reducerii impactului asupra mediului,* Revista Minelor, nr.1/2008, pag.7.

[5].A.Chitac, R.Sarbu- *Modern method for proccesing the coal slurry from Coroiesti settle pound*s. Annals of the University of Petrosani, 2009, pag.147.

[6]. O.Bold, C.Badulescu, D.Marchis-*Recovering of carboniferous fraction and other available mineral constituents, as an ecological change over of the sterile deposits from Jiu Valley* , 15-th International Multidisciplinary Scientific Geoconference SGEM, Albena, 2015, pag.675-681, ISBN-978-619-7105-31-5, ISSN-1314-2704.

[7].R.Sarbu – *Prepararea gravitationala,* Lit.Universitatii Petrosani, 1993.

[8].F.Tichnek, H.Juricova, R.Samkova- *Separation highly concentrated black coal slurry by using a froth separation.* 11-th International Multidisciplinary Scientific Geoconference SGEM, Albena, 2011,pag.1181

[9].F.Tichanek- *Posibility for application of froth separation procces in beneficiation of raw minerals.* Acta Montanistica Slovaca, 3/2005, pag.33.

[10].*Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities. European Commission*, Directorate General JRC Joint Research Center, Institute for Prospective Technological Studies, Technologies for Sustainable Development, European IPPC Bureau, Final Report, July 2004.

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DETERMINATION OF COAL MASS DRESSABILITY FROM WASTE DUMPS IN THE JIU VALLEY

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Abstract: The technological process of raw coal primary processing is carried out by some mass losses in the tailings discharged. Thus, in some areas of the tailings deposits calorific value exceeding 1500 kcal/kg. Because these components exist in mining tailings they constitute secondary resources of technological process.

Key words: coal waste dumps, coal processing, dressability

3. INTRODUCTION

Particularly due to the impact of mining activities on the environment, is urgently launch investigations related to limiting emissions on the environment in order to comply with legislation and protect the population, implicitly the right to a clean environment and sustainable development.

Mining activity has a negative effect on the environment, soil, water, air, vegetation, fauna and human settlements. Mining has a significant impact on soil primarily by: underground works, active and conservation dumps, tailings ponds, mining premises etc. The occupation of land surfaces, temporarily or permanently by waste dumps and tailings ponds is the main cause of the natural sealing of large areas of land. Currently along the length of Petrosani Basin there are located 41 waste dumps, of which 23 in operation and 18 donated to conservation and economic circuit. In addition, there are three ponds of flotation tailings.

2.THE DETERMINATION OF MINERALOGIC AND PHISICO MECHANICAL CHARACTERISTICS OF WASTE FROM DUMPS

Deposit waste rocks come from tailings resulting from the coal processing and underground mining tailings executed. In terms mineralogo-petrographic, this waste is represented by rocks that appear in the horizon productive horizon as clays and sandy clays, sandstone clay, marl, shale and carbonaceous graded microconglomerates varied. Field mapping and sampling in nozzles and in troubled state, certifies varying degrees of alteration of rocks depending by waste production and sampling.

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From preliminary observations we found that the mass of waste from branches dump is extremly complex composed from mixtures of rocks heterogeneous in terms mineralogico-petrographic and granulometric.

Macroscopic mixture of waste rocks is presented as a mixture of gravel and cobble caught in a mass of gray clay and sandy and sometimes after burning, reddish gray. The wastes resulting from preparations is represented by a mixture of clay, shale clays, sandy clays, carbonaceous shales, coal fragments.

Waste mass burning is initiated by the presence of granules of coal arrived in tailings processes of separation and concentration, loss of mass as fuel.

Following the slow seepage of water resulting from rainfall occurs moistening rock dump and tailings base deposited in its lower part and thus reduce their resistance characteristics. The presence of combustible mass among the other mineral components has importance in terms of how the distribution of particle size fractions, whereas part is associated as mixed for the issue to be subjected to grinding and then recovering coal.

Table 1 presents the physical and mechanical characteristics of the waste dumps from EM Lupeni.

Table1. The granulometry and the physical and mechanical characteristics of the mixture of waste dumps

Specification	U / M	Variation limits
Granulometric composition		
- clay (- 0,005 mm)	%	0÷4,2
- dust (0,005 – 0,05 mm)	%	2,1 ÷5,1
- sand (0,05 – 2,0 mm)	%	13,2÷38,9
- gravel (2,00 – 20,0 mm)	%	39,10÷69,8
- boulders (peste 20 mm)	%	4,0÷45,3
The specific weight	cN/cm^3	2,25 ÷ 2,55
Volumetric weight	cN/cm^3	1,62 ÷ 1,88
Humidity index	%	8,12 ÷ 8,76
Porosity	%	28,9 ÷ 36,17
Natural pore index	-	0,41 ÷ 0,55
Saturation coefficient	-	0,36 ÷ 0,97
Compressibility coefficient	$10^{-2}cm^2/daN$	1,10 ÷ 1,60
Compressibility module	daN/cm^2	62,5 ÷ 91,0
Specific slump	cm/m	3,15 ÷ 6,90

Taken into account the granulometry determination we proceeded to collect samples material from the branch no. II Lupeni. Samples were taken from the landfill body formed between pillar no. one and return station from three cross-sections as shown:

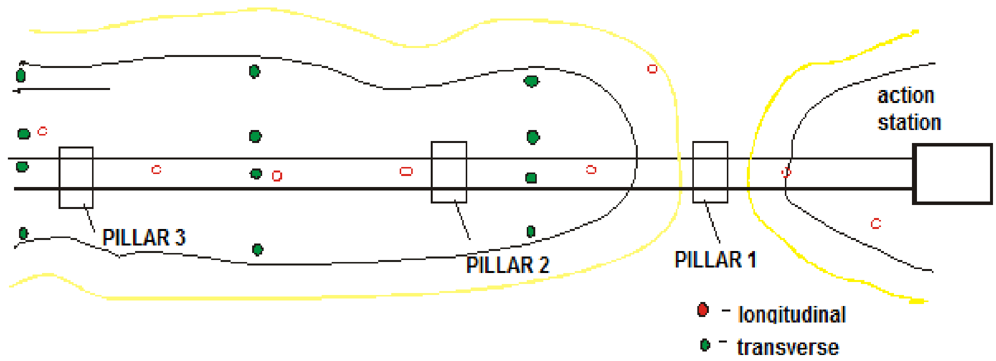

Fig. 1 The body of Lupeni (branch II) dump

Each section was chosen to collect four points of incremental samples, gathered in the sample which was then subjected to homogenization and quartered. After processing has proceeded to the analysis of particle size and determination of the ash contents on granulometric classes. The results are presented in Table 2.

Table 2. The granulometric results of samples 1,2,3

Granulometric class $d_i - d_{i+1}$ [mm]	Sample 1- section I (pilar 3– return station)		Sample2 –section II (pillar 3 – pillar 2)		Sample3 –sectionIII (pillar 2 – pillar 1)	
	quantity q_i [%]	ash y_i [%]	quantity q_i [%]	ash y_i [%]	quantity q_i [%]	ash y_i [%]
+80	5,94	85,71	2,90	87,89	3,3	80,01
80 – 40	22,01	78,73	13,53	82,84	8,81	76,02
40 – 20	21,05	73,07	23,96	73,26	29,34	77,17
20 – 10	11,66	74,85	10,74	71,89	10,91	78,19
10 – 3,15	18,21	76,24	25,47	72,61	21,82	78,31
3,15 –0,63	14,21	76,23	16,12	73,95	16,55	77,12
0,63 – 0	6,92	75,93	7,28	74,67	9,27	74,39
Total (average)	100	76,50	100	74,88	100	77,26

The data obtained are found relative homogeneity of the samples from the three sections and granulometric classes. However, class + 40 mm has ash content of 80%, and it is not advisable for processing in order to recover the fuel mass. Comparing average ash obtained from longitudinal sample collected (71.88%) with average ashes from multiple collection points on three cross-sections, shows that the latter has higher values (76.24%). The difference is explained by the increasing of samples number and relatively greater depth of those taken on cross-sections. Ashes lowest (74.88%) is in the middle section, between pillars no. 2 and 3, respectively of sample 2.

In table 2 is highlighted the ash contents of particles +40 mm and – 40 mm for the three tests and average on total dump compared with the sample collected on the branch II Lupeni.

Looking at the share class + 40 mm and ash on average sample compared to those collected longitudinal sections and their average shows the following differences:

- Share and ashes lowest class was + 40 mm per section III;
- Average of samples by sections show a lower percentage of class + 40 mm, but a higher ash;
- Class under 40 mm collected on sections is with a weight greater than the average longitudinal sample and ash over the value recorded at this sample.

From analysis of the ash distribution on granulometric classes it was not found noticeable differences to justify the removal of one of the classes. By sections, the lowest ash was determined to sample no. 2 class -40 mm, which would justify the elimination of class + 40 mm. In Figure 3 presents the graphical representation of particle size analysis and in Table 3 ash contents on granulometric classes.

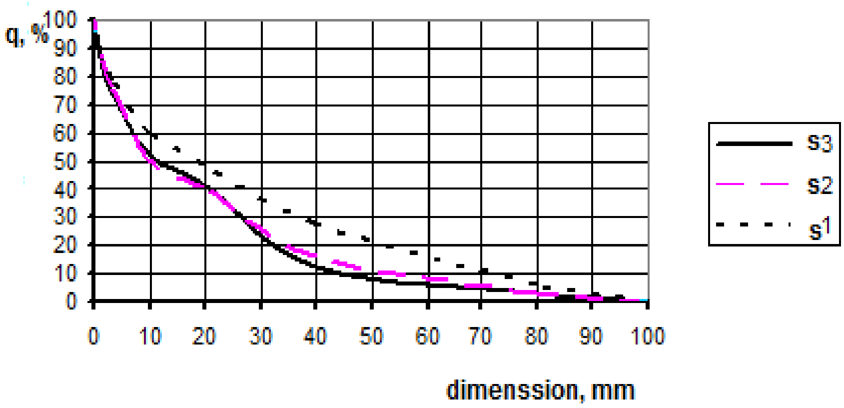

Fig. 2. Granulometric curves of waste collected on the 3 alignments branch II dump, Lupeni

Table 3. Ash contents on granulometric classes

Size class $d_i - d_{i+1}$ [mm]	Sample 1 (Section I)		Sample 2 (Secion II)		Sample 3 (Section III)		Average on cross sections		Average on longitudinal sample	
	q [%]	ash [%]	q [%]	ash [%]	q [%]	ash [%]	q [%]	ash [%]	q [%]	ash [%]
+40	27,95	80,21	16,43	83,74	12,11	77,11	18,83	80,57	31,23	76,0
-40	72,05	75,06	83,57	73,14	87,89	77,27	81,17	75,85	68,77	70,0
Total/ average	100	76,50	100	74,88	100	77,26	100	76,24	100	71,88

4. EVALUATION OF WASTE DUMP DRESSABILITY

The next stage of the analysis of samples collected in the three cross-sections of the branch II dump was to prepare a representative sample in order to establish the density distribution of components of waste dump. The results of densitometry analysis are presented in Table 4.(C.Badulescu, 2007)

Table 4. The results of densimetric analysis

Density class [kg/dm^3]	Sample no. 1		Sample no. 2		Sample no. 3	
	v_i [%]	y_i [%]	v_i [%]	y_i [%]	v_i [%]	y_i [%]
- 1,4	3,0	14,4	4,8	14,4	2,1	12,6
1,4 – 1,5	3,0	27,2	3,2	25,4	3,5	24,6
1,5 – 1,7	3,4	37.4	4,1	38,6	3,9	35,3
1,7 – 1,9	4,0	46.7	5,3	54,4	2,3	53,7
1,9 – 2,2	4,5	67.3	9,4	68,0	14,3	75,4
+ 2,2	82,1	81,8	73,2	85,1	73,9	84,9

Based on these were carried out calculations to trace dressability curves for each material sampled. At ash content which corresponds to the heat value of 3600 kcal / kg have been performed the theoretically recoveries possible to achieve by material processing. For Section I - located transversely dump body formed between pillar no. 3 and return station, we obtained HR curves shown in Figure 3.

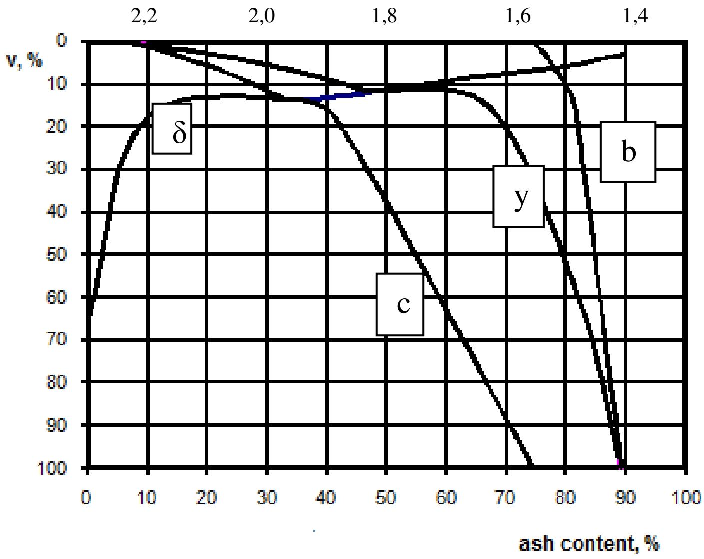

Fig. 3. Dressability curves for sample collected from section I, branch II, Lupeni

At 40% ash content for coal preparation, which provides a calorific value of around 3,600 kcal / kg results a theoretical recovery of 17.5%, under value obtained in the preliminary study (22.8), due to a higher ash content, by about 4 percent. The curve shape shows here the presence of disassociated material, which will worsen the combustible mass selectivity.

For the material of the second section placed between pillar no. 3 and pillar no. 2 the curves are shown in Figure 4.

The H-R curves for section III are presented in figure 5.(C.Badulescu, 2008).

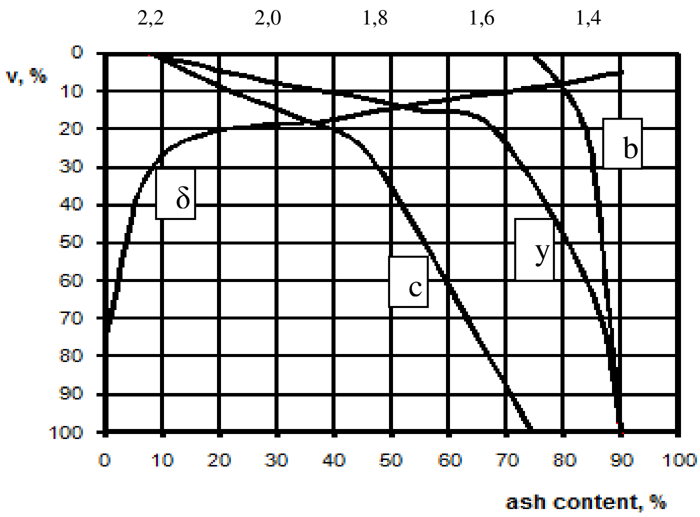

Fig. 4. Dressability curves H-R for sample of the second section

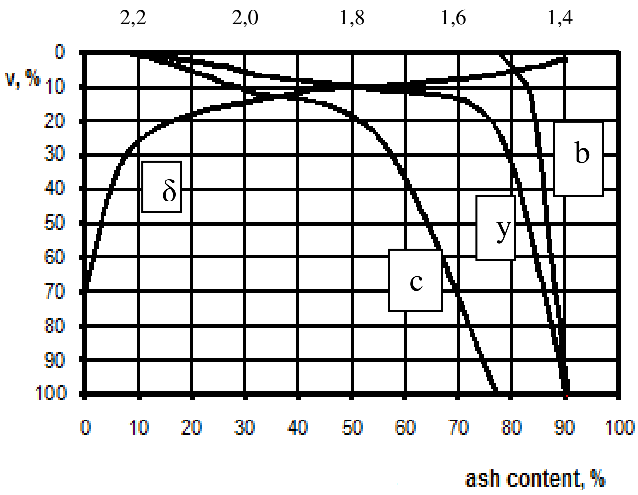

Fig. 5. Dressability curves H-R for section III

The ash of 40% for coal preparation, which provides a calorific value of around 3,600 kcal / kg results a theoretical recovery of 20.5%, close to that which resulted in the preliminary study and the largest of the three sections the dump body of which samples were collected.

Differences between the three sections sampled are not significantly large to justify the exploitation of selective portions of the branch dump.

4.CONCLUSIONS AND PROPOSALS

Currently in the Jiu Valley there are located 41 waste dumps, of which 23 in operation and 18 donated to conservation and economic circuit. In addition, there are three tailings ponds.

Macroscopic mixture of waste rocks is presented as a mixture of gravel and cobble caught in a mass of gray clay and sandy and sometimes after burning, reddish gray. The wastes resulting from processing plants are represented by a mixture of clay, shale clays, sandy clays, carbonaceous shales, coal fragments.

Granulometric analysis revealed a relative homogeneity of the three sections of the samples analyzed. However, class + 40 mm has ash content of 80%, and it is not advisable for processing in order to recover combustible mass.

- Share and ashes lowest class was + 40 mm per section III;
- Average of samples by sections show a lower percentage of class + 40 mm, but a higher ash;
- Class under 40 mm collected on sections is with a weight greater than the average longitudinal sample and ash over the value recorded at this sample.

Based on densimetric analysis were carried out calculations to trace dressability curves for each material sampled. At ash content which corresponds to the heat value of 3600 kcal / kg have been performed the theoretically recoveries possible to achieve by material processing

The ash of 40% for coal preparation, which provides a calorific value of around 3,600 kcal / kg results a theoretical recovery of 20.5%, for section III, the largest of the three sections the dump body of which samples were collected

REFERENCES

[1]. Bican, P. ş.a. – Consideraţii privind reabilitarea ecologică şi sistemul de management a zonelor afectate de exploatările miniere din Valea Jiului*, Sesiune de comunicări ştiinţifice – Universitatea din Petroşani*.

[2]. R.Sarbu, M.Georgescu, C.Badulescu – Surse de poluare si impactul lor asupra mediului in bazinul carbonifer Valea Jiului, *Revista de ecologie industriala, nr.4-5/1998, pag.37.*

[3]. C.Badulescu, R.Sarbu - Impactul activitatii de procesare a carbunelui din Valea Jiului asupra mediului, *Buletinul AGIR, NR.3/2006, pag.76.*

[4]. C.Badulescu - Posibilitati de valorificare integrala a slamului steril rezultat in urma procesarii carbunilor din Valea Jiului in vederea reducerii impactului asupra medilui, *Revista Minelor, nr.1/2008, pag.7*

[5].R.Moraru, G.Babut- The romanian coal mines closure process: selecting the most fitted hazard assessment method, *International Multidisciplinary Scientific GeoConference SGEM 2011.*

[6]. F.Tichanek, R. Samkova- Separation of highly concentrated black coal slurry by using a froth separation, *Multidisciplinary Scientific GeoConference SGEM 2011.*

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PRECIOUS METAL EXTRACTION FROM ASHES

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Abstract: *The paper present a synthesis of the research undertaken with a view to getting a better knowledge of the chemical, mineralogical composition and of the possibility to recover metals from the ash resulting from burning bituminous coal in the Jiu Valley, Romania. Taking into account the characteristics of the Jiu Valley ash, the research has been focused on hydrogravimetric preparation followed by electromagnetic separation. The concentrates obtained have been further subject to hydrometallurgical treatment by leaching with chlorination reagent, thus increasing the valves of precious metal extraction.*

Keywords: *ashes, precious metal*

1. INTRODUCTION

The coal is now and will be in the future the main energy resource, both in our country and abroad because of the important reserves and its burning capability. The ash is a consequences of burning the coal in termo-electric power station. It is the most important industrial waste, with significant economical and environmental impact by its big amount and its various recycling possibilities. The suitability of approaching this problem is imposed of factors, such as:

- a shortage of useful mineral sources;
- environmental protection;
- finding new sources of secondary raw materials liable to be used efficiently after being processed by classical or non-conventional technologies;
- the limited life - time of ash dumps.

The opportunity of any research in the field in the field of the ash valuation is given by the limitation of mineral resources and the need to preserve the environment, because the ash contain several recoverable minerals and waste deposits generate major environmental problems.

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2. ASSESSMENT OF PHYSICO-CHEMICAL AND MINERALOGICAL PROPERTIES OF ASHES

2.1.The ashes chemical composition

The ash contains some elements so called “major elements” in higher quantities (above 1%). The decreased order of these elements is: Si, Al, Fe, Ca, Mg, S, Na, K, Ti, P. The major elements distribution determines the oxide composition of ashes. Besides macroelements, in coals there are also microelements (between 1% and 1 ppm content). In table no.1 there are presented the macro and the microelements contents of ashes deposits from the Paroseni and Mintia thermoelectric plants. (Badulescu,C, Traista, E, 1998).

There were made some trials to obtain bricks with siliceous-aluminous ashes and the choice was based on the following conclusions:

- the microelements contents are very small comparatively with a minimal exploitable value and therefore, the idea of recovering these elements is not viable;
- comparing the microelements contents from the Jiu Valley coal and from the ashes resulted by burning it, it is obviously a tendency of few chemical elements enrichment, e.g: Ag, Au, Pb, Be, As, Mo, Ge etc.

Table 1. The major and microelements contents of ashes

Macroelements, %		Microelements, %	
SiO_2	47.12	Cu	0.039-0.055
Fe_2O_3	8.68	Pb	0.057-0.030
Al_2O_3	20.08	Zn	0.55-0.70
TiO_2	0.055	As	0.04
CaO	6.30	V	0.006-0.01
MgO	2.50	Mn	0.12
SO_3	0.22	Ni	0.005
Na_2O	0.98	Co	0.007
K_2O	1.87	S	0.22

2.2. The ashes mineralogical composition

The ash pond from Paroseni (Jiu Valley) and Mintia is a result of the superposition of two feeding sources, one inorganic and another of organic nature.

Above these two chemical and mineralogical basic structure there is a thermal structure with incombustible elements concentration.

The inorganic sedimentary zone is a clay mass which includes a chemical-mineralogical complex formed by iron and titanium oxides and hydroxides, calcium and magnesium carbonates and sulphates, iron, lead, zinc and native elements e.g.: gold, silver, platinum elements, etc.

The organic sedimentary zone is represented by the chemical elements accumulated in the plants mass from coal forming process. This organic mass contains the basic compounds such as: carbon, hydrogen, oxygen, nitrogen, but also a lot of useful elements from soil. These elements are: gold, silver, zinc, beryllium, cadmium, tin, tellurium, germanium, manganese, cobalt and nickel and in addition there are a lot of elements without nutritive value e.g.: sodium, chlorine, radium and rubidium. In the table no. 2 there is presented the mineralogical analysis of the ashes from the Paroşeni pond.

The physical analysis shows that the ashes deposit from Paroşeni and Mintia looks as a compact powder, microporous spheres or compact glassy spheres; other characteristics are: the grinding fineness is about 68% - 0.074 mm, low permeability and a high magnetic susceptibility.

Table 2. The mineralogical composition of the ashes pond

The mineral	**Chemical formula**	**Content (%)**
Magnetite	Fe_3O_4	10
Hematite	Fe_2O_3	
Sphene	$CaTi(SiO_4)$	0.1
Pyrites	FeS_2	0.35
Calcite	$CaCO_3$	3.0
Dolomite	$(Ca,Mg)CO_3$	
Pb, Zn, Cu sulphates and carbonates	-	0.1- 0.15
Metakaolinite	$Al_2O_3 \cdot 2SiO_2$	
Kaolinite	$Al_4(Si_4O_{10})(OH)_8$	30-35
Chlorite	$(Mg,Fe)_5(AlSi_3O_{10})(OH)_8$	
Artificial silicates	-	35-40
Quartz	SiO_2	5-10

2.3. The geo-chemical properties of the ashes

Based on geo-chemistry, the ashes from the Jiu Valley are grouped in: siderophile elements (Fe, Pt, Pd, Au), lithophile elements (Zn, Ag, Ga, In, Tl, Pb). There are two sources for the microelements from coals:

- elements from plants, e.g. : Fe, Zn, Au, Ag, Bi, Pt, Ge;

- elements accumulated in separable ash by deterioration processes, levigation, sedimentation and diagenesis e.g.: Si, Al, Fe, Mn, Ti, Zr.

The geochemical analysis has shown that the precious metals in ash are associate with the ferrous oxides.

3. RESULTS AND DISCUSSION

The research was focused on the recovery of precious elements from the ash with interesting grades, such as: Au: 0,22-0,44g/t; Ag :6,64-16,62g/t; Pt:0,1-0,78g/t, Pd:0,033- 0,038g/t which may present an economic interest. Taking into account the physico-chemical and mineralogical characteristics, the aim of ash processing is the obtain of a heavy product, respectively of a magnetic concentrate with high grade of precious metals.

Figures 1 and 2 show the particle –size analysis of ash in ash dump and the microelement content distribution according to granulometric grades, with the view of establishing possible distribution of the useful in a certain granulometric grade or for obtaining a granulometric grade, which is poor in the useful.(Badulescu C, Traista E.- 1998).

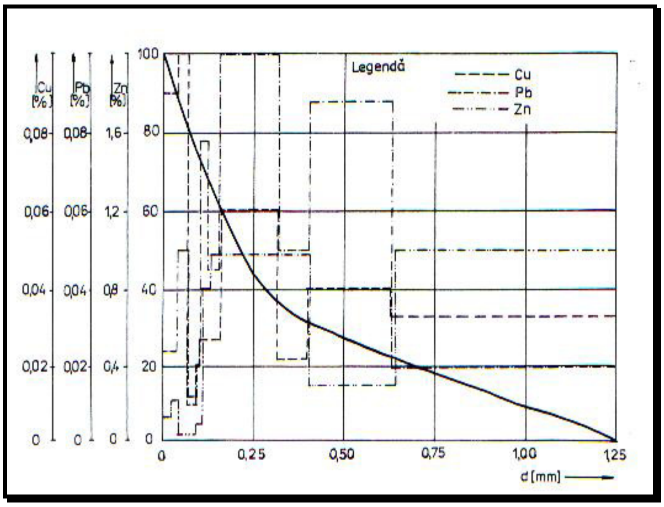

Figure 1. The variation content of Cu, Pb, Zn

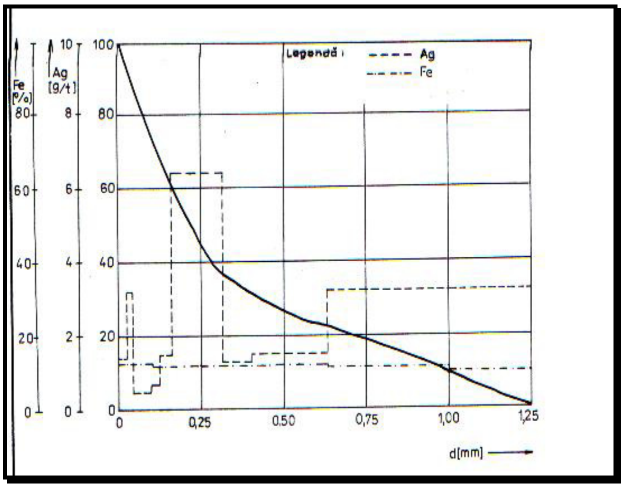

Figure 2. The variation content of Fe and Ag

Due to the very low content of chemical elements presented in table 1, the research has been focused on the recovery of precious elements from ash. Due to the siderophile character of platinum and to the calcophile character of gold and silver, these elements are associated with iron oxides represented by magnetite, hematite, limonite, including those resulting from burning pyrites whose share represents 8 - 11% in the ash mass.

In figure 2 one can notice an approximately equal distribution of iron and silver, which shows that none of these grades can be left aside in our study.

The chemical analysis made according to densimetric fractions have resulted in valuable information regarding the ash mineralogic composition. The Fe and Mn contents analyses per densimetric fractions have made evident the existence of Fe and Mn silicates, especially in the +2,8 g/cm^3 density range(figure3).

Taking into account the characteristics of the Jiu Valley ash, the research has been focused on hydrogravimetric preparation followed by electromagnetic separation.

Analyzing the results obtained in the laboratory stage, we find out, that by hydrogravimetric concentration on concentration table followed by electromagnetic concentration an intensity of the magnetic field of 1200Öe ferrous concentrates containing precious metals at weight extraction of about 3,5%.

In figure no.4 it is shown the technological scheme of the ash processing.

Three main products are obtained as a result of the ash recycling:

- a solid waste "**B**" for the construction materials industry (92.94% of ash mass, with 5.11% Fe);
- a radioactive nonmagnetic product "**R**"(1.14 % of the ash mass) with 0.016% U, which can be recovered; Any case, it must be relieved from the first component;
- a magnetic product "**C**" with precious metal content, 5.92 % of the ash mass, with 55.31 % of Fe.

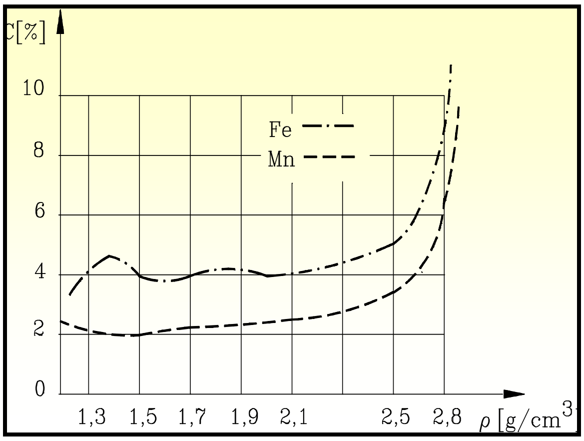

Figure 3. Variation of the Fe and Mn contents

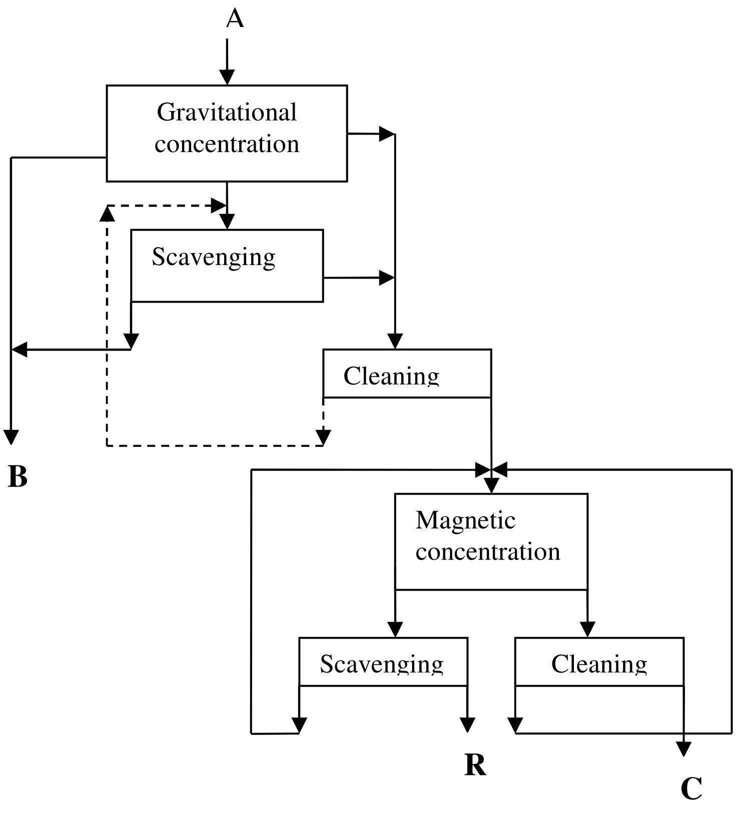

Figure 4. The processing of ash scheme (Bădulescu C, Andraş I, 1997)

The microscopic analysis made on concentrate samples points out that about 90% of concentrate is made up of mineralized grains, the rest forming micronic and submicronic associations between the iron oxides and the argillaceous minerals. The waste is made up of argilaceous minerals, micronic and submicronic association between the argillaceous mass and the iron oxides. This waste has been tested to usinf it in the building material industry and good results have been obtained.

The magnetic product with precious metal content was leacing with chlorination reagent. The control of the process of chlorinating dissoving of noble metals requires a thorough knowlwgw of the kinetics of this process. The best results werw obtaining treating concentrates with sodium hypochlorite, when gold goes in solution in the form of sodium chloraurate, platinum in the form of sodium chloroplatinate and silver in the form of sodium di-, tri-, or tetrachloroargentate.

Figure 5 gives the variation of extraction in metal, depending on time , during leaching with hypochlorite.(Badulescu C.-1998)

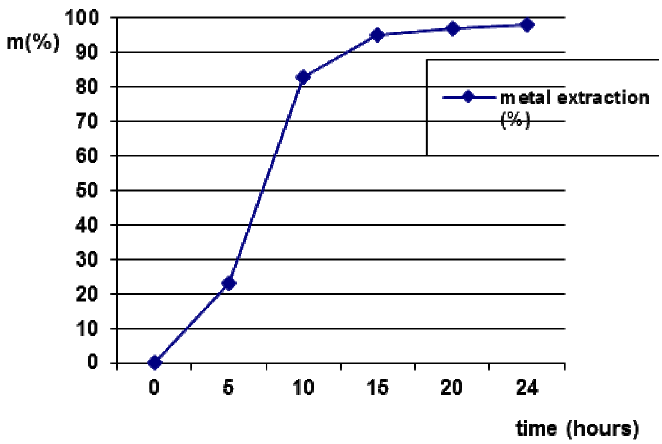

Figure 5. Variation of extraction in metal function time

The metal recovery is presented in table no.3

Table 3. Metal extraction in different components

Product	Weight extraction (%)	Content of Fe(%)	Metal extraction (%)			
			Fe	Au	Ag	Pt
Input "A"	100	8.26	100	100	100	100
Concentrate "C"	5.92	55.31	39.64	90.85	85.45	89.85
Non magnetic product "R"	1.14	20.19	2.79	0.31	1.90	1.33
Waste "B"	92.94	5.11	57.57	8.84	12.65	8.82

CONCLUSION

The building material industry and the building industry where have prevailingly been used up to now do not give optimum and integrated solutions as the ash composition and specific properties, which enable their recovery as sources of new metals have been ignored.

The Jiu Valley ashes contains a series of minor elements which can be used, such as vanadium, gold, silver and platinum.

Ferrous concentrates containing precious metals are obtained at weight extraction of about 3,5% by hidrogravimetric concentration and electromagnetic concentration .

The precious metals are obtained by hydrometallurgical treatment by leaching with a chlorination reagent.

REFERENCES

[1].**Badulescu C., Traista E**., *Researches Regarding the Possibilities to Extract Utile Compounds from Thermoelectric Plant Ashes (Romanian).* Revista Minelor, no.4, vol.85, 1998, pp.38;

[2].Badulescu C., Andras I., *Mathematical Model Setup of the Dependence between the Hydrodynamic Parameters of Hydrogravimetric Concentration of Ash Processing in Case of Thermoelectric Plant Ash Recycling,* **Proc. 6-th** Int. Symp. on Mine Planning and Equipment Selection , Ostrava, 1997, pp.831**;**

[3].Bădulescu C. ,*Cercetări privind posibilităţile de extragere a componenţilor utili din reziduul rezultat în urma arderii cărbunilor de Valea Jiului***,** Doctoral Thesis, University of Petrosani, 1998.

[4].Badulescu C., Traista E., Rusu M., *Waste deposit and recovery technology,* R.I. 1999;

[5].Imreh I., *Geochimie***, Ed. Dacia, Cluj - Napoca, 1989, p.153:**

[6]. Voina, N.I. ,T*eoria si practica utilizarii cenusilor de la centralele termoelectrice,* Ed. Tehnica, Bucuresti, 1981;

[7]. **Jingbang S., Hao Li.,** *Fly Ash Utilization in China* , 20th Proc. Int. Mineral Congress, Aachen, vol.5, 1997, pp. 109;

[8]. **Michalikova F, Florekova L.,** *Magnetic separation of energetical fly ashes,* 5-th Int. Symp. On the Reclamation Treatment and Utilization of Coal Mining Wastes, Ostrava, 1996,pp.267;

[9].**Michalikova F., Florekova L.** ,*Reclaining Of Utility Components By Treatment Of Energetical Fly Ashes,* Proc. 6-th Balkan Conference on Mineral, Ohrid, 1995, pp.358;

Nagy, B, Gonteanu, A. Possibilities of extracting iron from Thermoelectric Plant Ashes (Romanian), Revista Minelor, XXIII, nr.6/1972, pp.305;

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METHODS AND TOOLS FOR DETERMINING AIR-FLOW IN INDUSTRIAL VENTILATION INSTALLATIONS

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Corneliu BOANTĂ *

Abstract: *A ventilation system is defined by the exchange of air between the inside and outside environment in order to create ambient conditions as close as possible to the thermal comfort conditions required. Calculating the required air flow for ventilating a room can be quite challenging, and a wrong choice may lead to its inefficiency. Before installing a fan, there has to be analysed the space in which it has to be used and the method for compensating exhausted air (mechanically using another fan or naturally by dimensioned grids). For some rooms it is very challenging to calculate the air flow required for ventilation. It has to be calculated both for summer and for winter situation. Industrial ventilation and cooling systems aim to ensure air purity conditions and the proper microclimate for the activity carried out by the humans and for the type of technological process. Achieving these requirements contributes to maintaining the work capacity, to removing occupational diseases, to increasing the work productivity, quality of products etc.*

Keywords: *industrial ventilation, explosive and/or toxic atmosphere, microclimate, air flow*

1. MICROCLIMATE CONDITIONS

Industrial buildings usually include large spaces with various sources of harmful agents. Type of sources and their location depends on the technological process of each division. (Olga Bancea, 2009) In order to dilute harmful agents, to maintain environmental conditions necessary for safety at work and to achieve the microclimate required by the production process, large volumes of air are circulated through the industrial ventilation systems.

Structuring industrial ventilation systems requires thorough knowledge of the technological process (Alexandru Cristea, 1971), of machinery and their location,

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nature and quantity of harmful agents, environmental conditions required in terms of technology and safety at work. Computation bases and considerations in the field of apartment, administrative and cultural buildings remain valid in the case of industrial ventilation systems, with a number of particularities:

- When adapting a ventilation system, beside the constructive architectural constraints, also technological, operational restrictions and restraints related to the possibility of equipment placement emerge;
- In ventilated spaces, besides heat, humidity and CO_2 other harmful agents are released.

2. APPLICABLE VENTILATION SYSTEMS

The adopted ventilation system must take account of the technological process, density of sources, and propagation of harmful agents and the intensity of harmful agent's release. Systematic natural ventilation – in case of heated workshops without release of noxious vapours, gases or dust with high heat releases and less releases of moisture, mainly applied in the form of mixed ventilation or along with other systems. General exchange mechanical ventilation – applied when there occur releases of harmful substances and the systematic natural ventilation is insufficient. Local exhaust ventilation – used in order to improve working conditions in certain areas adjacent to sources of heat, strong radiant sources or to prevent entry of cold air through exterior doors.

Local air intake ventilation - when there are concentrated sources of harmful releases and general ventilation is insufficient even in large volumes of air. Local absorption and exhaust ventilation - for example in industrial ablutions.

Emergency ventilation - automatically turns on in case of large accidental releases of harmful substances occurrence as a result of technological equipment failures. Industrial air-conditioning- is required by the manufacturing processes, the need for precise conditions, in case of high precision processing, testing, and calibration.

3. AIR PROPERTIES

Air is the agent through which all ventilation and conditioning processes are accomplished. (Matthew I. Moraru, R, et al., 2000) As such, its properties directly influence the quality and quantity of phenomena participating in this process. In ventilation and air conditioning techniques, properties of interest are the chemical, thermodynamic and hygienic ones. Air is a mixture of gases, each having different physical and chemical properties. The main components of air are oxygen and nitrogen, besides which rare gases such as argon, neon and helium are present in low percentages and a variable content of carbon dioxide.

The pressure exerted on a gas consist of the atmospheric pressure and additional pressures such as those produced by fans and compressors. Airflow means performing mechanical work involving energy consumption (power). This power can be supplied by a machine such as a fan or other sources such as heat.

4. VENTILATION NICHES

Local ventilation systems (Doru C., C. Lupu, Gheorghe I, 2013; Niculescu, N., Duta, Gh., Stoenescu, P., Cold, I., 1982) can be classified according to the nature and spreading manner of harmful releases, type and size of equipment, particularities of technological processes, constructive composition of premises, etc. Depending on how they provide local working conditions we may have:

a. Local exhaust ventilation installations - in situations in which ensuring microclimate conditions require the use of air jets in the form of air showers or air curtains;
b. Local absorption ventilation installations - when harmful substances are concentrated, their entrapment is performed on-site by:

- Open devices: hoods, marginal aspirations;
- Semi-closed devices: ventilation niches;
- Closed devices: casings;

Local absorption and exhaust ventilation installations - are systems that locally entrap harmful substances, if for the equipment housing cannot be performed in current work conditions, by creating, through air jets discharged on one side and entrapped on the opposite side, a curtain above the source which to limit the spreading of harmful substances and to provide the air's directed movement into a geometrically space confined or not; the system is used for: industrial ablutions, drying tunnels, electrolysis tanks. Ventilation niches may be found in the form of work benches, shaded on three sides, having a working space and access in the front, open / closed during operation/use. Niches can be of laboratory or industrial type.

Depending on inside air directing manner, dictated by density of released harmful substances in relation to inside air density, we may have:

- Niches with absorption openings at the top (figure 1a);
- Niches with absorption openings at the bottom (figure 1b);
- Niches with absorption openings at the top and at the bottom (figure 1c, d).

Ventilation niches can be made of blackboard, zinc-plated sheet, stainless steel, plastic, glass, polystyrene reinforced with glass fibre, etc., depending on the aggressiveness of entrapped harmful chemicals.

In premises having more niches, depression conditions between rooms will avoid spreading the released harmful substances, or mixing with various other harmful emissions. Measures taken are intended for avoiding explosive, flammable or highly corrosive mixture. The best solution would be for each niche to be backed by a compensation fan or air treatment assembly. The economic version is accepted, by grouping niches on exhaust systems with joint groups for compensating locally evacuated air, but while ensuring differentiated depression conditions between premises.

In Figure 1, the represented laboratory niche has the following components: 1-work bench; 2- niche body; 3-partition; 4- sash window; 5-upper absorption opening; 6-bottom absorption opening; 7-additional absorption hole; 8- technological fluid connections (water, gas, compressed air etc.)

For local absorption niche type devices, the question of determining air speed in the niche's free section rises, provided that these concentrations of noxious substances released in counter current to the air flow do not exceed, past the worker, the allowable concentration value.

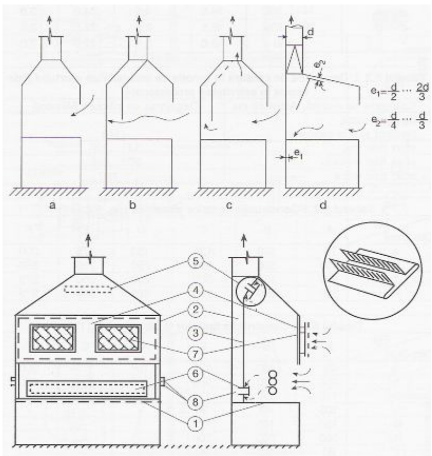

Figure 1. Types of ventilation niches

If the concentration of harmful substances in the niche is known, denoted by y_0, absorption speed v will be measured, satisfying the condition that, at a distance x=a, the value y_a of allowable concentration is observed. (Figure 2).

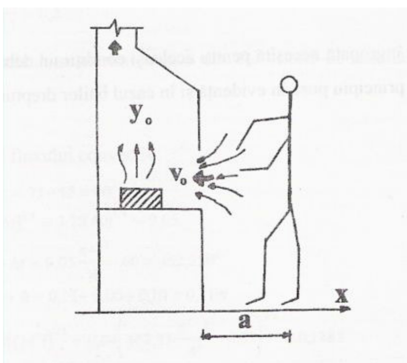

Figure 2. Niches calculation scheme

The concentration of harmful substances within the niche y_0 depends on the flow of pollutants released, the internal volume and the niche's aerodynamics. Working conditions require distance between worker and niche (denoted by *a*) and the requirements for health and safety at work require an allowable concentration value y_a.

$$y_a - y_0 e^{-\frac{v}{A}a} = 0 \qquad or \qquad v = \frac{A}{a}\ln\frac{y_0}{y_a} \tag{1}$$

According to this equation, for slowing down the absorption and airflow speed, diffusion coefficient A and concentration of harmful substances in niche y_0 will have to decrease, because increasing the distance and allowable concentration y_a cannot be achieved in working conditions, with respect to work safety.

A decrease in concentration of harmful substances within the niche can be provided, if an evacuation by absorption is achieved, differentiated depending on density and ascending forces of harmful releases. Another solution to reduce the concentration is to increase the niche's volume or to input additional air at the bottom of the niche, but provided that there is no leakage of pollutants within it. The kinetic energy of internal air currents has an influence on the diffusion coefficient A and on the turbulences around the absorption opening of the niche. Local turbulence can be attenuated by installing aerodynamic edges on the absorption opening's contour. The ventilation system will have to be linked with the movement of air currents caused by movement of workers, machinery, equipment and convective currents produced by heat sources. For industrial departments having specific indoor air turbulence, diffusion coefficient A, after *Elterman* is:

$$A = 2{,}5\varepsilon^{\frac{1}{3}} d^{\frac{4}{3}} \tag{2}$$

where:

- ε - represents the room's specific kinetic energy based on the weight of air in the room in m^2/s^3;

- d – equivalent diameter of the niche's absorption opening in m.

For open hoods, air velocity in the absorption section plan can be determined based on the following approximate data, which must also be verified with the equal velocity curves:

- for entrapping water vapour v = 0.3 m / s;
- for entrapping gases and vapours whose allowable limit concentration is higher than of 0.1 mg / l, v = 0.5 m / s;
- for entrapping polluted air with a temperature of 30 ÷ 70 ° C, v = 0.7 m / s;

- for entrapping air polluted with toxic substances or when the temperature exceeds 70 ° C, v = 1 m / s.

5. AIR FLOW MEASUREMENT TOOLS

The main parameters involved in the definition of ventilation and air conditioning installations are: air pressure, air velocity, temperature and humidity.

The air pressure is measured with the U air gauge, micro air gauge with liquid and with pressure probes or tubes.

The flow rate is a parameter characteristic for fluids in motion, and represents the quantity of fluid passing per time unit through the area unit.

For measuring flow we can use:

- Frontal measuring systems with differential pressure cells,
- Systems with electromagnetic transducers,
- Variable area measurement systems,
- Positive displacement measurement systems,
- Turbine transducers systems,
- Ultrasonic transducers systems,
- Vortex extinction transducers systems,
- Thermal transducers systems,
- Coriolis transducers systems, etc.

Flow measurements are related to the principle of mass conservation, showing that a static mass which enters a system in a time unit is equal to the mass exiting the system, in the same time unit.

Flow measurements refer to fluids, flow of solids being measured by weighing and counting. Fluids whose flows are measured may be liquid, gas, steam and suspensions.

Flow rates are measured in open or closed ducts, except gas flow rates, which are measured only in closed ducts.

6. CONCLUSIONS

Ensuring the microclimate conditions which are appropriate for work carried out by people or technological features of the process, consists in maintaining or limiting to specific values the agents which guarantee environmental quality of an industrial site. The microclimate of a premise involves maintaining to specific values the following parameters:

Thermal comfort agents: air temperature, relative humidity, air velocity, mean radiant temperature, clothing thermal resistance;

Secondary agents: air cleanliness, ionization degree, noise, biological factors, lighting level, radiations.

In industrial departments in which are released concentrated harmful substances, local entrapment systems can be applied or they can be endued with absorption, exhaust or absorption and exhaust devices. These systems limit the spreading of harmful substances and ensure air parameters in the work area. The solution of increasing the ventilation flow in order to achieve allowable concentrations of harmful substances in the work area generates high air velocities and risk of spreading harmful substances throughout the entire volume of the hall.

ACKNOWLEDGEMENTS

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REFERENCES

Alexandru Cristea, *Air ventilation and conditioning,* Technical Publishing House, Bucharest, 1971

Doru C., Lupu C., Gherghe I,. *Guide for dimensioning industrial ventilation installations,* INSEMEX Publishing House, 2013.

Olga Bancea, *Industrial ventilation systems,* Editura Politehnică, Timimișoara, 2009.

Matei, I., Moraru, R, ş.a, *Environment engineering and underground ventilation,* Technical Publishing House, Bucharest, 2000.

Niculescu, N., Duţă, Gh., Stoenescu, P., Colda, I., *Ventilation and air-conditioning installations*, E.D.P., Bucharest, 1982

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TESTS ON INERTISATION OF OIL SLUDGE RESULTED FROM OIL EXTRACTION ACTIVITIES

Ioan Cristian RUS IOAN *
Gabriel DIMIRACHE *
Stela DINESCU *

Abstract: *In the industrial activity occur in many cases technical incidents followed by crude oil contamination of adjacent areas, i.e. liquid petroleum products. Spreading liquid petroleum products to the soil surface may have negative effects on both the subsoil and groundwater by infiltration and the atmospheric air by evaporation of pollutant compounds with high volatility. Making remediation of a site contaminated with petroleum liquid and its sustainable ecological restoration and is one of the most complex environmental projects, both in the technical, economic and organizational. Choosing the optimal remediation technologies technically and economically is a difficult decision because a large number of involved parameters and a large number of interactions that influence the system and make it virtually impossible to control completely the final results.*

Keywords: *oil sludge, characteristics of the oil sludge, inertization, effects of pollution*

1. INTRODUCTION

In the industrial activity occur in many cases technical incidents followed by crude oil contamination of adjacent areas, i.e. liquid petroleum products.

Spreading liquid petroleum products to the soil surface may have negative effects on both the subsoil and groundwater by infiltration and the atmospheric air by evaporation of pollutant compounds with high volatility. Making remediation of a site contaminated with petroleum liquid and its sustainable ecological restoration and is one of the most complex environmental projects, both in the technical, economic and organizational. Choosing the optimal remediation technologies technically and economically is a difficult decision because a large number of involved parameters and a large number of interactions that influence the system and make it virtually impossible to control completely the final results.

The composition and structure of the soil, together with the nature of the organic part gives the system and the humidity of their physical-chemical

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* *University of Petrosani*

characteristics very different. On the other hand, the volume and composition of the oil contribute to the soil contaminating system with very different characteristics.

With such diverse systems remediation technology selection is made on empirical principles that take into account primarily the availability and less than scientific issues.

Before you decide which technology is most appropriate remediation of a specific situation should carry out a diagnostic inventory in which to establish:

- The composition and structure of the soil in the contaminated area;
- Qualitative and quantitative characterization of the pollutant;
- Extending to the surface and depth of the polluted area;
- The degree of quality degradation of soil germination;
- Negative effects of pollution on human activity in the area;
- Risk of groundwater contamination.

If current pollution delineation of contaminated areas can be achieved by a variety of factors that depend on the nature and location of the pollutant source, amount and pollutant characteristics, such as the relief of the area, soil composition and structure of the system - the basement - groundwater .

Determining the extent of contaminated areas at ground level and basement or the first underground water is combining direct visual observation method (from the ground or air means type helicopter, airplane or satellite photos) specific analysis methods for determining pollutant content of soil samples, surface water or groundwater.

Given the relatively high cost of pollutant analyses of soil samples and surface water and groundwater have established the optimal strategy in terms of the number of analysis and precision needed for delineation of contaminated areas.

For these cases it is recommended that the sampling of soil or contaminated water to realize the concentrated system, the source of the pollution.

If historical pollution, usually not known when exactly the position of the source of pollution or when there was a source distributed mode contaminated delimitation is based on information obtained from analysis of samples pollutant in the system uniformly distributed on the surface potentially polluted.

Information obtained through analysis of pollutant to be supplemented by information obtained from scenarios that shape the evolution of pollutant in time and space.

Inventory of contaminated areas include elements that relate to:

- Inventory site with detailed information on the location, technology flows installations / equipment related neighbouring sewage system and so on
- Inventory flows with accurate information about potential pollutants (identification, quantity, their variability over time, etc.),
- Inventory sources of pollution, effluent quantification, assessment and validation causes pollution
- Estimated with an accuracy as high as the extent of the contaminated area, both at ground level and in depth.

The information contained in the inventory of contaminated sites are needed to establish optimal remediation strategy.

2. PHYSICO-CHEMICAL CHARACTERISTICS OF OIL SLUDGE

Slurry resulting from the extraction of crude oil consists of deposition of particles of minerals (sand, clay) strongly impregnated with oil in separators, tanks, catch basins related to oil flow in the scaffold (parks collectors-separation station oil-storage treatment, wastewater treatment plant). In appearance these are in the form semisolid sludge.

Mechanical impurities in the oil are solid inorganic or organic nature (minerals) that form sediment (slurry or sludge) that sinks to the bottom of tanks for storing crude oil.

From the extraction process, the collection and treatment of sludge resulting in varying amounts depending upon the amount of oil extracted and processed, for slurries that are stored in pits located apart from separation units. Waste material deposited in deposit is made and composed of:

- liquid phase - waste water, storm water, oil;
- phase semi - material debris, heavy petroleum fractions, drilling mud.

By gravitational separation bund surface forms a film of oil that is captured and evacuated by a pump periodically sip phone on the right in the park.

Generally, the slurry obtained has the following features:

- Water content varied as slurries stored in bunds are from different backgrounds;
- Content of volatile and implicit oil content from sludge varies greatly from sample to sample;
- Calorific different from one sample to another;
- Different sulphur content;
- Variable density from 1.17 to 1.22 kg/dm^3;
- Percentage of water 25-39%;
- Volatile 15-31%;
- Minerals 60-84%;
- 0.05% sulphur;
- Calorific power 720-900 kcal / kg;

Sludge resulting from purification tanks collection, separation and storage of crude oil and the cellars, wells clippings are collected and stored in specially designed pits subsequent to recover the oil. These pits are located within the separator parks, warehouses and storage of crude oil treatment and sometimes near the extraction wells and / or central battle.

The laboratory determined the characteristics of the oil sludge, resulting in the table 1.

In order to obtain a waste inerted (non dangerous) will mix the following material components (figure 1):

1. Slurry oil at a rate of 30-60%;
2. Residues of coke, charcoal or wood chips in a proportion of 35-65%;
3. Lime in a proportion of 5 - 10%.

Mixing is done on a concrete platform covered:

1. deposit a 10 cm layer of coke residues, charcoal or wood chips
2. deposit a layer of 30 cm oil sludge.
3. Adds lime by spraying
4. They adds a layer of 10 cm of coke residues, charcoal or wood.chips

Table 1 The laboratory determined the characteristics of the oil sludge

Sample	Win	Aanh	mcin	Qinf
	[%]	[%]	[%]	[kcal/kg]
Sample 1	34.45	51.99	31.47	2262
Sample 2	11.87	43.93	49.41	3819
Sample 3	6.99	53.18	43.55	3347
Sample 4	25.69	73.47	19.72	1312
Sample 5	20.10	60.66	31.43	2302
Sample 6	24.59	69.27	23.18	1603
Sample 7	45.14	25.33	40.96	3017

The results of physic chemical analysis pa raw material are presented in the table 2.

In order to obtain an inerted (harmless) waste , one will mix the following material components:

1. Slurry oil at a rate of 30-60%;
2. Residues of coke, charcoal or wood chips in a proportion of 35-65%;
3. Lime in a proportion of 5 - 10%.

Mixing is done on a concrete platform covered:

1. Deposit a 10 cm layer of coke residues, charcoal or wood chips
2. Deposit a layer of 30 cm oil sludge.
3. Adds lime by spraying
4. They adds a layer of 10 cm of coke residues, charcoal or wood chips

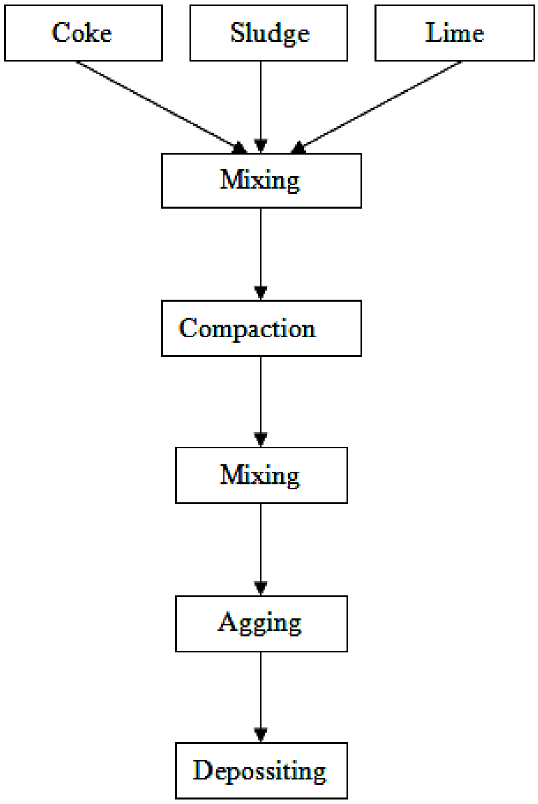

Figure 1. Technological flow scheme proposed

Pressing material will be achieved by repeated passage over a SCC mixture.

After the material has achieved at a degree of compaction of more than 80% will pass to its loosening by means of a compost turning machine.

Such material will leave the rest loose at least three days to complete neutralization and adsorption reactions of volatile compounds by coke.

Advantages it presents the proposed technology are:

- oil sludge transformation, which is hazardous waste, into composite materials marketable, with the characteristics of nonhazardous waste;
- permanently remove waste treated by conversion to solid fuel.
- the resulting solid fuel combustion ash material that has characteristics of inert waste.

To determine the inerting of the waste recipes were carried out using three sets of test adsorbent material is coke, in a proportion of 35%, 25% and 15%.

The results of the tests of inertization carried out with the addition of the adsorbent material in a proportion of 35% are shown in the table 3:

The results of the tests of inertization carried out with the addition of the adsorbent material in a proportion of 25% are shown in the table 4.

The results of the tests of inertization carried out with the addition of the adsorbent material in a proportion of 15% are shown in the table 5.

From the above data it is observed that by mixing with inert adsorbent material obtained a mass with certain energetical characteristics.

Table 2 The results of physico chemical analysis pa raw material

Sample	1	2	3	4	5	6	7
A anh	73.4680	43.9348	53.1827	60.6604	69.2659	51.9899	23.3271
MgO	0.0410	0.0811	0.0571	0.2188	0.0306	0.0000	0.0000
Al_2O_3	0.9861	1.0810	1.3806	1.7340	1.7103	0.6884	0.1544
SiO_2	6.5104	4.5398	6.9098	7.4924	8.8604	3.5236	0.7823
P_2O_5	0.0586	0.0832	0.0727	0.0444	0.0456	0.0504	0.0000
SO_3	2.8307	1.1277	0.8716	1.1991	1.4398	1.1363	0.7340
Cl	0.1561	0.0282	0.0386	0.0570	0.0563	0.0243	0.0222
K_2O	1.2944	0.7613	1.4923	1.2767	1.5792	1.0136	0.0000
CaO	9.0034	11.5887	5.3302	7.6842	7.1774	9.8464	1.0425
TiO_2	3.8440	2.0776	2.8396	2.0082	3.4084	3.0045	0.9264
V_2O_5	0.6606	0.3847	0.1200	0.4563	0.2610	2.7330	0.0000
Cr_2O_3	0.7710	1.2448	0.0000	0.7624	1.2669	0.0000	0.7809
MnO	0.9325	0.2492	0.3774	0.5696	0.5980	0.4171	0.1207
Fe_2O_3	25.7830	16.4362	27.6780	25.4778	34.6262	19.3288	8.2948
Co_2O_3	0.0000	0.0000	0.0000	0.0000	0.1565	0.0000	0.0000
NiO	0.1382	0.0550	0.1256	0.1746	0.1460	0.1759	0.1111
CuO	0.2281	0.0000	0.0000	0.0920	0.2049	0.1251	0.0537
ZnO	0.0000	0.0000	0.0000	0.1074	1.0878	0.0731	0.2529
Ga_2O_3	0.1610	0.0000	0.0666	0.0000	0.1343	0.0831	0.0000
GeO_2	0.4782	0.2838	0.3774	0.3920	0.4435	0.4542	0.2790
As_2O_3	0.0000	0.2310	0.4986	0.5639	0.6052	0.0000	0.0933
SeO_2	0.1397	0.0532	0.0589	0.0000	0.0000	0.1255	0.0000
Br	0.1067	0.0457	0.0498	0.0000	0.1157	0.0594	0.0446
Rb_2O	0.2013	0.0000	0.0000	0.0000	0.0000	0.0327	0.2839
SrO	0.3729	0.1559	0.1630	0.1696	0.2460	0.2599	0.0902
ZrO_2	0.0000	0.0000	0.1325	0.0000	0.0000	0.0000	0.3679
MoO_3	0.0000	0.0000	0.0000	0.0495	0.0366	0.0000	0.0000
CdO	0.4540	0.0000	0.0000	0.3096	0.0000	0.0000	0.9739
BaO	9.4409	1.0787	2.1908	1.6694	0.5969	3.9407	1.0901
PbO	1.4288	0.0000	0.0000	0.0000	0.0000	0.0000	0.1056

Table 3 The results of the tests of inertization carried out with the addition of the adsorbent material in a proportion of 35%

	Win	Aanh	Vanh	Qinf
Sample 1	2.79	43.86	20.80	4275
Sample 2	2.66	30.47	36.18	5364
Sample 3	2.75	33.82	27.23	5087
Sample 4	26.96	61.63	26.47	1998
Sample 5	2.46	37.22	28.73	4829
Sample 6	2.86	21.88	38.77	6044

Table 4 The results of the tests of inertization carried out with the addition of the adsorbent material in a proportion of 25%

	Win	Aanh	Vanh	Qinf
Sample 1	0.59	44.19	29.06	4357
Sample 2	0.25	52.51	17.24	3685
Sample 3	1.83	33.60	37.82	5158
Sample 4	1.42	37.49	30.80	4865
Sample 5	1.24	48.74	23.80	3952
Sample 6	0.64	48.65	22.13	3986

Table 5 The results of the tests of inertization carried out with the addition of the adsorbent material in a proportion of 15%

	Win	Aanh	Vanh	Qinf
Sample 1	0.59	44.19	29.06	4357
Sample 2	0.25	52.51	17.24	3685
Sample 3	1.83	33.60	37.82	5158
Sample 4	1.42	37.49	30.80	4865

3. CONCLUSION

Oil industry generates large amounts of waste oil, including oil slurries that have the strongest negative impact on soil and surface water sometimes;

Petroleum wastes are included in the category of hazardous waste, also considered persistent pollutants;

By mixing with the adsorbent material as coke dust, these wastes can be stabilized and brought to the characteristics of non-hazardous waste, except of course the parameter "total organic carbon";

Inerted resulting product has real energetic characteristics, can be mixed with coal and burned in power plant designed to burn any coal with a volatile content of over 20%.

4. REFERENCES

Bohîltea I. -*Reactoare chimice*, Ed. U.P.G. Ploieşti,1996.

Bran Florina, Dineu I. -*Ecologie generală şi protecţia mediului*, ASE, Bucureşti,1995.

Nicoleta Ionac, Sterie Ciulache, *Aspecte ale poluării mediului în a realele cu industrie petrolieră şi petrochimică din judeţul Bacău*, 2000.

http://www.ecologic.rec.ro/articol/read/actualitate/2204.

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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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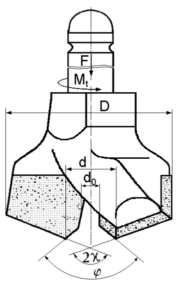

Fig. 1. Detachable bit

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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).

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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.

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

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