STUDY ON THE RECLAMATION OF THE STERILE WASTE DUMPS AS THE RESULT OF UNDERGOUND MINING IN JIU VALLEY

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Abstract

The mining industry has adversely affected all the environment parameters; consequently, today it is imperiously necessary to perform rehabilitation and to reclaim the damaged land.

This paper presents the current situation of the sterile waste dumps in the Jiu Valley and several proposals to clean the adversely affected areas.

This paper is grounded on the observations carried out in the field, on the informations gained as a result of studies (Environment balance sheets / Risk evaluations) that have been carried out by INSEMEX Petroşani in the Jiu Valley, the physical and the mechanical characteristics of the dumped rocks and of the foundation rocks determined by the University in Petroşani.

1. Generals

Until 2010, there were 42 sterile waste dumps in the Jiu Valley; they belong to the mine units and to the processing plants and enclose around 37 mil. M^3 and cover a surface of 258 ha. 43% of the dumped sterile comes from underground mining, 22% from surface mining and 34% from the processing plants. For the first situation, the dumps represent the result of the sterile rock taken from the headings in sterile and of the sterile selection from the useful mineral substance.

Most of the dumps in the Jiu Valley are being located along valleys and slopes, near mine units and inhabitated areas.

These waste dumps are located on surfaces of land which may be used for agricultural or forest purposes; they pollute the underground waters and the air due to dust emissions or by self-ignition of the mining mass and of slimes resulted after processings.

Dumping shall depend on the mining method, on the physical and mechanical properties of dumped rocks, on the relief of the surface where dump is being made, on the transportation system, on the dumping method etc.

Generally, the soil on waste dumps suffers a shortage of salts and bases to the prejudice of humic acids and other acids. Consequently, the particles in soil are less saturated in basic substances (of calcium, magnesium, kalium etc.).

Figure 1 shows the inactive waste dumps in the Jiu Valley that can be reclaims. These dumps have had their sides gradiented, leveled and saplings have been planted. At present, these waste dumps have been stabilized and some dumps contain water discharge piping that crosses the dumps. To fight against the lack of stability, there have also been performed drainages of the water accumulated at the base of gradients, i.e. ground filling and gathering of rain waters into guard canals. Also, energy breaking thresholds have been made at the ends of gradients, with discharge into the creeks neighboring each dump.

2. Aspects regarding the stability of waste dumps

In general, the sterile deposits in the Jiu Valley are being located in areas characterized by water accumulations under the form of small lakes/ponds together with the specific vegetation (bulrush etc.).

In order to be able to check out the stability of rocks that form the waste dump, it is necessary to know the physical indicators of necessary to know the physical indicators of rocks (they characterize rocks in their natural conditions from a qualitative standpoint) and the mechanical indicators (they characterize the behavior of rocks under mechanical stress from a quantitative standpoint).

The main factors that influence the stability of waste dumps are the following ones:

- the shape of the ground used for dumping purposes;
- the types of rocks and the regime of underground and surface waters;
- the physical and the mechanical properties of the rocks that are being dumped and of the base land;
- the dumping method that is being used;
- the geometrical characteristics of the waste dump.

The geotechnical characteristics of the dumped rocks that have been determined by the laboratory of Geotechnics at the University in Petroşani (tab.1).

For most of the times, there are being used analysis methods based on the limit balance state; they represent calculation methods used to define the stability of natural or artificial gradients.

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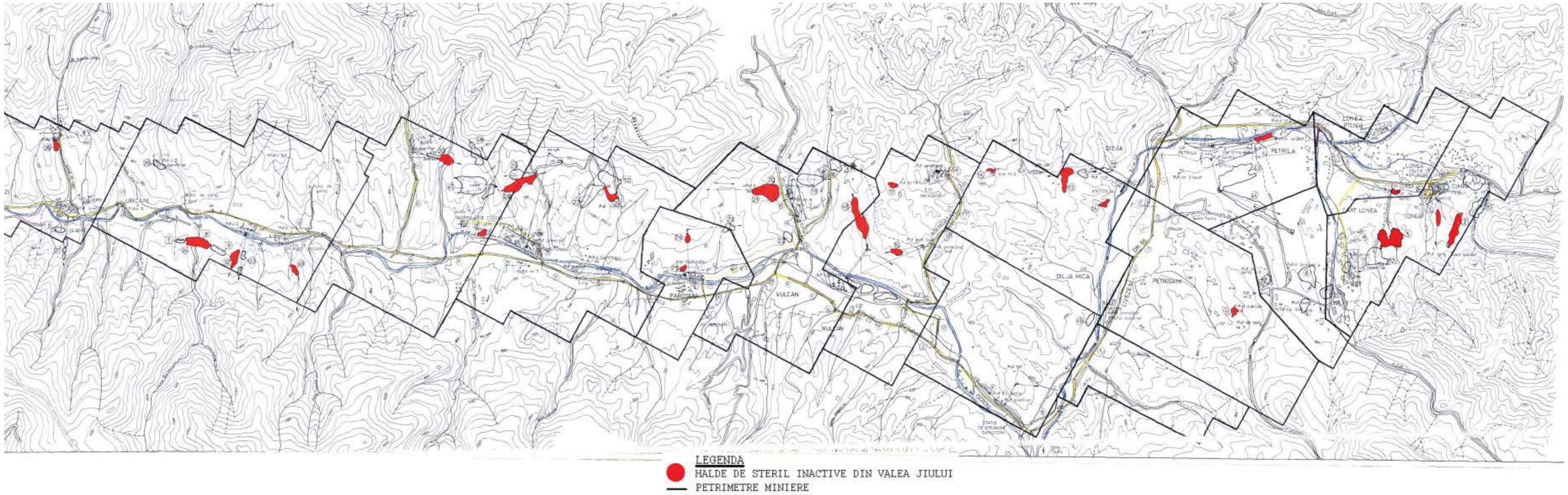

Fig.1 *Location of sterile waste dump in the Jiu Valley coalfield*

Fig.2 *Ileana waste dump belonging to Lupeni Mining Unit*

Fig. 3 *Priboi waste dump belonging to Aninoasa Mining Unit*

Table 1 *Physical and mechanical characteristics of rocks from the sterile waste dumps in the Jiu Valley*

Sample no.	Sample name	INDICES FOR A GENERAL IDENTIFICATION							INDICES ON NATURAL CONDITIONS						MECHANICAL INDICES		
		Grain size							Determined in laboratory			Calculated					
			Pietriş														
		Stones < 20 mm [%]	Ø = 10 - 20 mm [%]	Ø = 2 – 10 mm [%]	Sand Ø = 2 – 0,05 mm [%]	Dust Ø = 0,05 – 0,005 mm [%]	Clay Ø < 0,005 mm [%]	Characterization of the rock in relation to its grain size	Specific quantity γ_s [cN/cm^3]	Volume weight γ_s [cN/cm^3]	Natural humidity W [%]	Porosity n [%]	Pore ratio ε	Saturation ratio S	Compressiblity $E_{\beta*10^{-2}}$ [cm^2/daN]	Deformation ratio Ec [daN/cm^2]	Specific setllement Es [cm/m]
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Sample from the waste dump, alternated P_7/R_v	18,5	14,5	34,0	14,0	12,2	6,8	Pietriş cu bolovăniş	2,35	1,63	11,55	37,82	0,60	0,45	1,61-1,67	62-59,8	3,7-4,1
2	Sample from the waste dump washed P_3/R_v	30,0	20,0	25,2	15,0	7,5	2,3	Pietriş cu bolovăniş	2,44	1,76	23,85	41,76	0,71	0,82	1,91-2,1	52,3-47,6	7,6-7,9
3	Sample from the waste dump P_3/R_v	24,0	22,0	18,0	22,6	9,7	3,7	Pietriş cu bolovăniş	2,18	1,67	11,96	31,58	0,46	0,56	2,0-2,28	50-43,8	7,1-8,7
4	Sample from the waste dump P_2/R_v	18,3	15,4	30,5	19,4	14,0	2,4	Pietriş cu bolovăniş	2,41	1,74	14,27	36,8	0,58	0,59	1,87-2,15	53,4-46,5	6,6-7,2
5	Vegetable soil P_8/R_v	-	-	8,0	46,0	36,6	9,4	Praf argilo-nisipos	2,60	1,75	19,08	43,48	0,76	0,65	2,36-2,98	42,4-33	4,1-6,5
6	Vegetable soil down the waste dump P_1/R_{Iv}	-	-	5,4	27,3	34,8	32,5	Argilă prăfoasă	2,63	1,84	24,5	43,8	0,78	0,83	2,24-2,81	44,6-35,6	3,8-5,2

These methods check-up the required conditions necessary for the stability of the mass that makes up a gradient, especially to check up equilibrium of forces or of moments. The methods, based on similar criteria, state the modeling of the gradient under analysis, defining the loading condition and the adoption of a tearing criterion. Consequently, all these analyses shall depend on the type of the model that has been adopted and on the physical and mechanical properties assigned to the materials.

The most often used methods for checking up the stability of waste dumps are the following ones:

- Fellenius method – is a method easy to apply with covering results, since the normal strains at the base of the breaking surface don't play any influence on the resistance to shearing;
- Simplified Bishop method – the most suitable one for routine calculations, in spite of the fact, that it doesn't meet all the equilibrium conditions;
- Janbu and Sarma methods are considered the most accurate ones because they take into consideration the complex topography of the ground, with non-homogenous layers, different resistances and with sliding surfaces of no-definite form.

Based on the researches that have been carried out until now, the following measures are recommended so as to provide a good stability of waste dumps located on slopes (this situation often appears in the Jiu Valley):

- the internal friction angle of the dumpted rocks be larger than the inclination of the surface of the base ground and the slope of the dumped rocks be much smaller than the slope of the surface of the base ground;
- the internal friction angle of the dumpted rocks be larger than the internal friction angle of the rocks in the base and the slope of the dumped rocks be much smaller than the natural slope of dumped rocks.

When these conditions are fulfilled simultaneously, the waste dump shall maintain its stability as long as no other external factors interfere.

3. Influence of sterile dumps over the environment from a chemical and pedological point of view

According to the Order no. 756/1997 issued by MAPPM, there have been sampled soil from the waste dumps that belong to different mines.

The qualitative parameters of samples were determined by the Laboratory for Environment at the University in Petroşani.

If the qualitative and the quantitative evaluations of the chemicals traces in soil and of its fruitfulness are compared to the parameters that characterize fruitfulness stated by the methodology issued by the Institute for Pedological Researches in Bucharest, the following conclusions may be drawn:

- the samples taken from the perimeters of the sterile waste dumps were determined for phenols, traces of heavy metals, polycyclic aromatic hydrocarbons and oil hydrocarbons; their values are within the admitted limits stated in the Order no. 756/1997 (they situate under the limit of the alarm threshold for soils with a less sensitive use);
- we have also concluded that these soils display a low fruitfulness, being characterized by a low acid pH, average humus, very poor assimilable P and an average assimilation of K. In spite of all these, there are some vegetation on some sterile waste dump;
- all the surfaces that have been sampled are not part of soils for a sensitive use; they are part of soils with a less sensitive use and this aspect resulted from the reclamation operations that were carried out.

As a conclusion, we may say that there are no contaminations with metals or compounds but fruitfulness of soils has been affected; consequently, measures to improve the quality of soils are quite necessary.

4. Measures for the recovery of environment and land reclamation

Anthropic operations have diminished both the fruitfulness and the balance of eco-systems, even if vegetable associations haven't disappeared.

The mining operations have adversely affected large surfaces of land.

We recommend the following measures for the recovery of environment and land reclamation, based on literature, field studies:

- ➢ the berms of waste dumps shall be arranged in such a manner so that the rain waters flow easily;
- ➢ the sterile waste dumps shall be stabilized by tree planting with varieties that can adapt to be acid pH and to the poor fruitfulness soil;
- ➢ the natural environment shall be recovered;
- ➢ the platforms of waste dumps shall be leveled with cylinders for waterproofing and development of slopes of 3% min. with the fall towards the external shape of waste dumps;
- ➢ all through the period necessary for the recovery of waste dumps, there shall be used double amounts of fertilizers (compared to the normal ratios) with the rotation of cultures.

Monitorization of the environment parameters of the reclaimed waste dumps shall take into consideration:

- flora;
- fauna;
- lands, together with its analysis;
- water quality (surface and underground waters);
- how pews grow;
- whether the spring of saplings is less than 50%, there shall be a re-sowing;
- every 3 years there shall be studied the chemistry of soil to determine its fruitfulness;
- the land stability shall be determined by topographic measurements made by monitoring alignments.

5. Conclusions

The main source for the pollution and the degradation of lands in the Jiu Valley is the underground mining and storage of large amounts of sterile mass.

To sterile waste dumps occupy forest or agriculture lands, they pollute underground waters and air by dust emissions or self ignition of the mining mass and of slimes resulted after processing processes.

For all the cases under analysis there results that the present technical condition of dumps is good with no unstable areas or phenomena that forecast slidings. Possible slidings can occur only in those areas where the rock resistance characteristics change as a result of their alternations and increased humidity or when the ratio between the strain forces of gradients and resistance forces change.

The reclamation of lands occupied by sterile waste dumps shall lead to a diminished pollution of the environment parameters in the Jiu Valley and its introduction into the natural environment.

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