EXPLOITATION OF BAUXITE FROM PADUREA CRAIULUI MOUNTAINS AND THE IMPACT ON ENVIRONMENTAL FACTORS

Radu BREJEA[7], Cristian DOMUTA[8], Eugen JUDE[9], Andrei NISTOR[10]

Abstract. *The paper presents the impact of the exploitation of bauxite in the Pădurea Craiului Mountains on the environmental factors. The extraction of bauxite was carried out by surface quarries and underground galleries. Exploitation of this field irrespective of the established method produces a significant impact on environmental factors. For this reason it is compulsory to establish some works, solutions that will lead to the restoration and ecological reconstruction of these mining perimeters, whether they are quarries, tailings dumps or tailings ponds. The present paper presents bauxite quarries in Zece Hotare, Bihor County, the impact on the environment as well as a series of technical measures to reproduce the economic cycle of degraded and polluted land.*

Keywords: bauxite, quarry, galleries, pollution, environment.

1. Introduction

Bauxite is an ore or a mixture of mineral substances, consisting mainly of aluminium hydrates, iron oxide, alumina silicate and titanium oxide. The bauxites appear in amorphous compact or earth mass, and the most sought-after bauxites are those with low silica content (SiO2).

The country with the largest production of bauxite in the world is Australia. It is followed by Guinea and Brazil. A remarkable growth of bauxite production was recorded in China, India and Jamaica.

During 1990-2006, Romania appears as a bauxite producer. Since there were bauxite deposits in Transylvania there were also various attempts to set up an aluminium industry to capitalize on this deposit. The interest for the bauxite ore in the Pădurea Craiului Mountains manifested after 1900. Its exploitation also took place before and during the First World War, but preferentially, i.e.

[7] University lecturer, PhD, engineer BREJEA Radu - Corresponding Member of the Academy of Romanian Scientists, University of Oradea, Faculty of Environmental Protection
[8] University lecturer, PhD, engineer DOMUTA Cristian - University of Oradea, Faculty of Environmental Protection
[9] Senior lecturer, PhD, engineer – JUDE Eugen - University of Oradea, Faculty of Environmental Protection
[10] PhD Student, engineer NISTOR Andrei - University of Oradea, Faculty of Environmental Protection

exploitation made of ore bodies located at the surface, namely at Tomnatic, Zece Hotare, Valea Poienii, Valea Iadului and Bratca, which presented favourable economic conditions for the technology of that period.

Following complex studies carried out in the next period by the Geological Institute, a number of remarks were made on the composition of the bauxites and the rocks accompanying the deposit, conclusions that had the effect of improving the technological flow of the aluminium metallurgy in our preparation units.

The bauxites from the Pădurea Craiului Massif are chemically and mineralogically characterized by the constant presence of Al-Fe-Ti elements, whose minerals entirely form them. All these minerals resulted from precipitation processes, hydrothermal metamorphism and alteration, generating existing bauxites.

Among the bauxites in the Pădurea Craiului Massif, the red-cherry bauxites (up to 95%), which are also the main aluminium ore, dominate categorically. The research that led to these conclusions was made in the areas where these bauxites are located, namely: Zece Hotare, Schireaua, Cornet, Brusturi, Brejeşti, Vîrcorog, Roşia-Albioara, Lunca Sprie and Remeţi. It is remarkable that the structure of bauxites varies in their mineralogical composition and colour. Depending on these, the bauxites from the Pădurea Craiului Massif were divided into:

- Primary bauxites to this category fall the bauxites, which have the colour of cherry, red, brown and black;
- Secondary bauxites this category includes red, pink, yellow, white and ash bauxites.

The existence of this ore led to the organization of the exploitation, so in 1963, the "BAUXITA CHISTAG" mining operation was founded, which belonged to the Oradea Mining Trust. In 1965 appears the Dobreşti Mining Company, belonging to the Ministry of Mines, being responsible for the exploitation of bauxite in Bihor County, even if it undergoes different name changes, namely in 1990 it becomes MINERAL EXPLOITATION DOBRESTI, then it turns into S.C. BAUXITA MIN. S.A in 1994.

The mining objective of S.C. BAUXITA MIN. Dobreşti consists of several perimeters of exploitation and utility groups dispersed on a very wide area, comprising a part of the Borod depression, south of the Cluj-Oradea national road, the Bucea-Aleşd-Ţeţchea section, a large part of the Pădurea Craiului Massif between Remeţi and Vărciorog, extending to the southern alignment Dobreşti-Roşia - the dam of Leşu on Valea Iadului. The bauxite exploited in these areas, either through surface or underground operations, was transported to the enrichment stations at Chistag and Dobreşti. The bauxite was then transported by rail to the bauxite processing plant in Oradea. This plant was called: S.C. ALOR

S.A. and has as activity profile the production of tabulated alumina and calcined alumina.

The placement of the bauxite resources in the Pădurea Craiului Mountains

The bauxite deposit occupies a territory between Crişul Repede, Crişul Negru, the Dragan River and the Roşia River.

The geographic location of the bauxite deposit in the Pădurea Craiului Mountains, and especially the first three regions are surrounded by railway lines, favouring the operation in good conditions, making the necessary arrangements for transporting funiculars, trucks, etc.

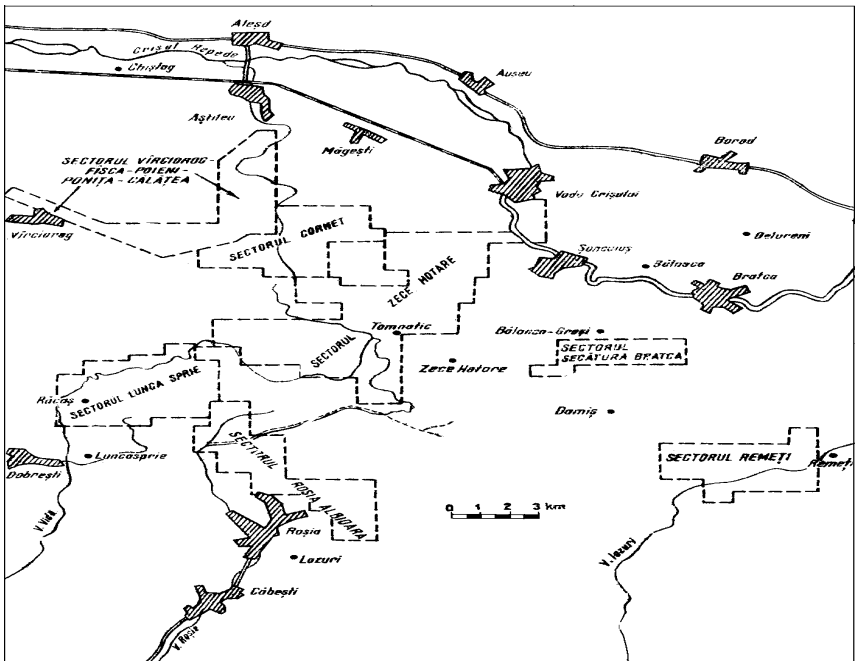

Fig.1 The area with bauxite resources from the Pădurea Craiului Mountains

The bauxite placement mode on the soil profile

The exploitation of bauxite by surface quarries depends on the arrangement and location of the bauxite deposit that differs from one operating area to the other, as well as the depth at which the bauxite is found. As it can also be seen in the adjacent figures, the bauxite deposit in the Pădurea Craiului Mountains, almost in all cases, is confined to the limestone.

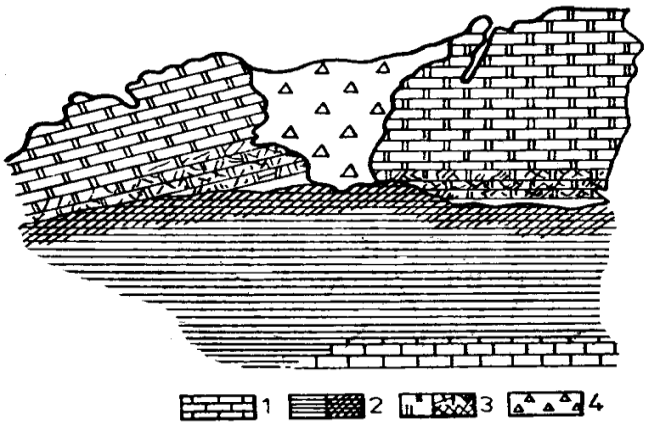

Fig.2 The Schireaua bauxite resource diagram (36/64 lens), after V. Papiu)
1 – limestone (Jurassic superior); 2- bauxite 3 – limestone; 4 – lehm bauxitifer

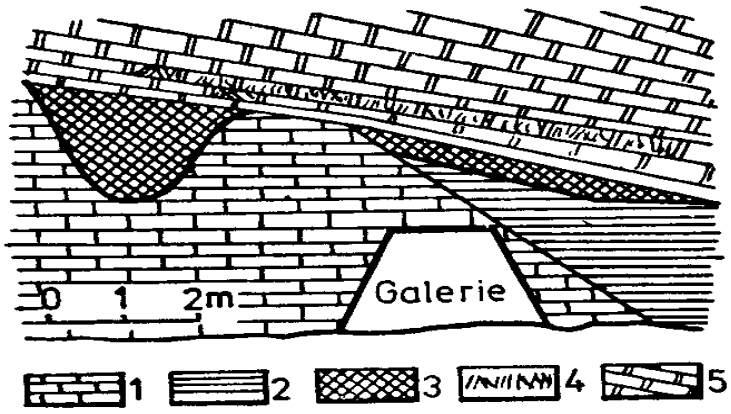

Fig. 3 The Cornet bauxite resource diagram, (after V. Papiu)
1 – Jurassic limestone; 2- cherry bauxite; 3 – iron depleted bauxite;
4 – Neocomian brecciated limestone; 5 – massive Neocomian limestone;

2. Methods for bauxite exploiting

The opening concept includes all the mining work in the underground or on the surface, which provides the necessary conditions for the rational and efficient exploitation of the deposits.

Consequently, choosing the optimal solution to open a mining operation is a highly responsible operation. The optimal solution will take into account the complexity of all the acting factors (economic, social and environmental).

The Piatra Craiului Massif has had bauxite reserves that are confined to deep steps. In the first depth step of 0-150 m there are a series of perimeters such as Chicera, Piatra Şoimului, Astileu, Valea Cubleşului, Zece Hotare and Răcaş.

The second stage, where the bauxite reserves are at a depth of 150-350 m, these reserves are located in the perimeters of Remeţi, Dealul Măgurilor – Valea Lazuri.

The third step refers to the bauxites located at depths greater than 350 m, comprising the perimeter on the western side of the Pădurea Craiului Massif.

Depending on the depth at which the bauxite ore is located, its exploitation can be done by:

1. Underground exploitation is the work that is being carried out for extracting large-scale ore. In order to establish the correct method of opening, a number of factors influence the choice of the method. The main factors of influence are of geological, technical and economic type.
2. Exploitation of the day or in the quarry is a complex of the works made for the exploitation of the deposits that are at a low depth.

3. Materials and research methods

The quarry covered by the present study is located in Zece Hotare, Bihor County, in the Pădurea Craiului Mountains. A map of land use in this area is shown in Figure 4.1. The exploitation of bauxite ceased in 1998. The surface of the former bauxite quarry is of 10 hectares.

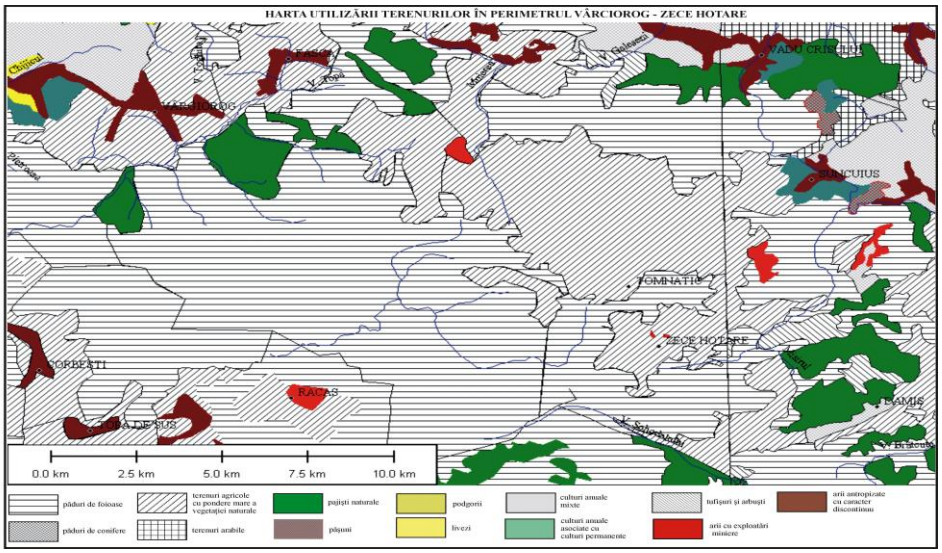

Fig. 4 The land use map in the Vârciorog-Zece Hotare area, Bihor

Fig. 5 Bauxite quarry in Zece Hotare, Bihor County
Surface occupied by the bauxite exploitation quarries from the Pădurea Craiului Mountains

In the case of Dobreşti mining, the area occupied by the quarries is of 130,575 m^2, plus other land that has been set aside either temporarily or permanently, these lands come from the access roads, tailings dumps resulting from underground exploitation, as well as tailings ponds.

Table 1. Surfaces occupied by bauxite quarries managed by S.C. BAUXITA S.A. Dobreşti

No.	Exploitation area	Type	No. of quarries	Quarry (m^2)
1.	Cornet	Forest	12	43,273
2.	Roşia-Albioara	Forest	15	84,242
3.	Vărciorog	Forest	1	8,292
4.	Zece Hotare I	Forest	7	12,300
5.	Zece Hotare II	Agricultural	2	2,468
6.	Total	Forest	35	128,107
		Agricultural	2	2,468
7.	Total degraded terrain			130,574

From the bauxite extraction technology results a slurry that is stored in the tailings ponds. The Dobreşti Mining Exploitation holds two tailings ponds, namely: the Chistag Tailings Pond is a rib pond located on the major riverbed of Crişul Repede, with a height of 12.5m; the Dobreşti decantation pond consists of two bodies, one on the Vasia valley being 14.5 m high and the second one located

on the Vezinoşi valley having a height of 32 m and consisting of two compartments. The situation of the areas occupied by the tailings ponds is presented in

Table 2. Surfaces occupied by ponds

No.	Placement area of the ponds	Occupied area (m^2)
	Dobreşti ponds	358,493
	Chistag pond	308,890
	The total area occupied by ponds	667,380

4. Results and discussions

The mining operation at Zece Hotare, in its long existence, has affected all environmental factors, which is why the issue of rehabilitation, the use of mining waste for various purposes and the degradation of degraded land in the economic circuit is now very serious. Bauxite deposits are depleted by exploitation only in a few decades, leaving behind surfaces for which man and nature together have to make a common front for their reconstruction.

The ecological rehabilitation of the quarry in Zece Hotare involves the bringing into the economic circuit of degraded land areas through exploitation activities, so it is compulsory to develop re-cultivation technologies. One of the methods that can lead to the restoration of these soils is the generation or regeneration of the soil cover on the areas degraded by the industry which is an original method of re-cultivation, another possibility of restoration being the reproduction in the economic circuit of degraded and polluted lands.

The restoration in the economic circuit of land from mining exploitations means all the work being done to transform these areas into productive areas for agriculture, forestry, fish farming, whose output is comparable to the original results. Re-cultivation of land degraded by mines to date is the action of restitution of useful capacity or production of soils through technical and biological treatments. Re-cultivation implies, at the same time, the use of all means of reducing the surface of the land, affected by the exploitation and liquidation of the damages caused by the degraded soils.

The technical-mining rehabilitation of the quarries from the operation of the bauxite at Zece Hotare requires the passage of some technological stages, namely: levelling the surface of the quarry; fighting erosion in quarries; forest re-cultivation.

1. Land levelling is one of the most important operations in the recovery process. Without proper levelling, uniform soil reproduction cannot be achieved. Depending on the geometry of the quarry, the levelling works must start immediately after the career is stable to work safely.

2. Works to fight soil erosion are part of the measures to prevent erosion, landslides and soil degradation. In quarries, regardless of whether they are on agricultural, pasture or forest land, they require this work, because after the levelling of the land if no action is taken, the erosion occurs.

3. Forest re-cultivation can begin even from the stage of levelling the land. Afforestation is usually done with seedlings of different essences depending on the local silico-climatic conditions and the nature of the pits. Generally, seedlings are planted at distances of 4 m and after about 4 years. If the soil still requires activation and enrichment in humus, then a variety of fast growing and non-planting trees is planted, which will then be replaced with tree species of high economic value. The mature tree transplantation process can be used both in the improved and untreated lands. Some of these works are also valid for the tailing pond where other specific technologies need to be applied.

REFERENCE

[1] Brejea R., *Tehnologii de protecţie sau refacerea solurilor* (Editura Universităţii din Oradea, Oradea, România, 2009).
[2] Canarache A., *Fizica solurilor agricole* (Editura CERES, Bucureşti, România, 1990).
[3] Domuţa C., Brejea R., *Monitoringul de mediu* (Editura Universităţii din Oradea, Oradea, România, 2010).
[4] Fodor D., *Exploatari miniere la zi* (Litografia I.M.Petroşani, România, 1975).
[5] Huidu E., Jescu I., *Cartea minerului din exploatărilor la zi* (Editura Tehnică, Bucureşti, România, 1987).
[6] Huidu E., Jescu I., *Conceptii tehnologice de exploatare in cariera*, (Editura Tehnică, Bucureşti, România, 1993).
[7] Jelev I., Brejea R., *Sisteme aplicate de management al mediului înconjurător* (Editura Universitaţii din Oradea, România, 2006).
[8] Jitereanu G., *Ingineria conservării solului şi apei. Curs* (Ed. Univ. Agronomice şi de Medicină Veterinară, Iaşi, România, 1995).
[9] Lazăr M., *Reabilitarea ecologică* (Editura Universitas Petroşani, România, 2001).
[10] Lăzărescu I., *Aluminiu – seria Substanţe minerale utile* (Editura Tehnică Bucureşti, 1978).
[11] Lăzărescu I., *Protecţia mediului înconjurător în industria minieră* (Editura Scrisul Românesc, Craiova, România, 1983).
[12] Miclăuş V., *Pedologie ameliorativă* (Ed. Dacia, Cluj-Napoca, România, 1991).
[13] Neag Gh., *Depoluarea solurilor şi apelor subterane* (Ed. Cărţii de Ştiinţă, Cluj-Napoca, România, 1997).
[14] Păcurar I., *Pedologie forestieră* (Editura Academicpress, Cluj-Napoca, România, 2005).
[15] Răuţă C., Cârstea S., *Prevenirea şi combaterea poluării solului* (Editura Ceres, Bucureşti, România, 1983).
[16] Rusu T. şi colab., *Fizica, hidrofizica, chimia şi respiraţia solului - Metode de cercetare* (Editura Risoprint, Cluj-Napoca, România, 2007).
[17] Samuel Alina Dora, *Evaluarea microbiologică şi enzimologică a efectelor tehnologiilor agricole asupra biologiei solului* (Ed. Universităţii din Oradea, România, 2003).