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THE STUDY OF PHYSICAL, CHEMICAL AND ENZYMATICAL PROPERTIES OF THE LAND FROM A FORMER BAUXITE QUARRY IN THE PĂDUREA CRAIULUI MOUNTAINS IN THE CONTEXT OF ECOLOGICAL RECONSTRUCTION

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Abstract: The paper is based on the researches carried out in a former bauxite quarry from Zece Hotare, Bihor County. The bauxite exploitation ended in 1998 and in 2004 complex works took place in order to set up experiments. In 2005, 2006, 2007 and 2008 determinations were made as to what concerns the settling of herbs vegetation. The three soil profiles located in the levelled area and the slope area were compared to the profile of the soil from the limitrophe beech tree (*Fagus silvatica*) forest. In the profiles from the former bauxite quarry, the colloidal clay content increased significantly compared to the soil from the limitrophe beech tree (*Fagus silvatica*) forest. The bulk density, the total porosity and the hydraulic conductivity had lower favourable values and the pH values were lower. The humus content was determined only on a 0 – 30 cm depth and on a 0 – 17 cm in soil profile from the hillside. Phosphorous and potassium had low values. The enzymatical activity - the actual dehydrogenase activity, the acid phosphatase activity, the catalase activity, the urease activity – was reduced in the soil profiles from the former bauxite quarry than in the beech tree (*Fagus silvatica*) forest. The process of vegetation settlement (*Robinia pseudocaccia*) was severely influenced by fertilization, and the herbs vegetation was influenced by its location in the quarry, the number plants grew from one year to another. Thus we can strongly affirm that the reconstruction process is underway.

Keywords: bauxite quarry, physical, chemical and enzymatical properties, vegetation, ecological reconstruction.

1. INTRODUCTION

The bauxite quarries in the Pădurea Craiului Mountains located Zece Hotare, Roşia – Albioara and Vârciorog and they spread on a total surface of 1.305.740 m^2.The surface can be supplemented with fields which were took out of the agricultural or forestry circuit, access roads, waste and tailing dumps. Due to economical reasons the exploitation of bauxite ceased in the early 1990, (Brejea et al., 2006, Brejea, 2008).

The crop of the degraded soil through social – economical activities involves a complex system of measures (technical – mining, hydro-melioration, soil management that are meant to rehabilitate the degraded soil's fertility and create a land shaft proper for agriculture, forestry and other socio–economical activities, (Blaga et al., 2004, 2007, Damian & Damian, 2006, Damian et al., 2008, Domuța, 2005, Ross et al., 1992, Samuel et al., 1999, Sandor et al., 2007, Wigfull et al., 1987).

As far as for the technology used for recultivation the degraded soils, it implied two stages: the technical–mining stage that managed the exploitation material, transportation and storage and the measures needed in order to fight the negative phenomena (soil acidity, soil erosion) ensemble of the primitive technogen soils capable of ensuring the durable plant formation with self tuning capabilities, (Nițu et al. 2000, Craioveanu et al. 2008, Mărăcineanu et al. 2008).

The complexity of the processes involved in the soil remediation lead to the proposal that the recultivation should be part of a scientifically discipline called „ecocreology", (Nițu et al. 2000).

2. STUDY AREA

The Pădurea Craiului Mountains represents the area between the Crişul Repede River and the Crişul Negru River from the Apuseni Mountains. They are separated from the Vlădeasa Mountains and the Bihor Mountains, by the Iada and Meziad Valleys. In North it reaches the Oradea – Bratca depression, in South the Beiuş depression and in the West the Tăşad hills. Having this outline, the Pădurea Craiului appears like a relatively suspended plateau, mainly formed from Mesozoic limestones with heights over 1000 m only in some parts (1027 m in Hondringuşa) in the East; as we proceed towards West they constantly decrease to 400 – 500 m close to Vârciorog and Bucuroaia (525 in Dealul Poiana and 442 m South West to Vârciorog). These formations are made out of Mesozoic limestones associated with the metamorphic schists and Permian conglomerates, sandstone and ryolites.

Bauxite can be found in Pădurea Craiului, Remeți, Pietrosul regions of the Apuseni Mountains. The bauxite resources are located in the area extent between the Crişul Repede River, the Crişul Negru River and the Roşia River.

The bauxite exploitation was made on the surface and in underground quarries. The bauxite from the Bihor Mountains has varied colours, from grey to dark brown, mostly dark red. The colour of the bauxite is associated directly with chemical composition. The bauxite from the Pădurea Craiului Mountains, Zece Hotare has the following chemical composition: SiO_2 = 4.2%, TiO_2=2.5%, Al_2O_3=58%, Fe_2O_3 = 22.8%, H_20 = 11.7%. The bauxite from Pădurea Craiului Mountains and from the other Romanian areas has a medium quality, determinated by the high content of SiO_2.

The annual rainfall average is 6151 mm, 585.2 mm in 2005, 872.0 mm in 2006, 585.2 mm in 2007. The multiannual average of the temperature is 10.2ºC. The average for 2005, 2006 and 2007 were of 9.2ºC, 9.2º C and 11.5º C. The air has a moderate humidity, and multiannual average of 78%, and the values from 2005, 2006 and 2007 are 81%, 79% and 76%.

From a hydrographical point of view the Pădurea Craiului Mountains have two main basins: the first one is the Crişul Repede River with it`s affluents: Valea Miarăi, Gălăşeni, Mişid, Brătcuța, Boiul and Iadul that ensure drainage on the northern slopes of the massif, and the second one is Crişul Negru with it`s affluents: Topa, Valea lui Vasile, Rosia – Albioara - Sohodol, Meziad, Lazuri on the southern part.

The Pădurea Craiului Mountains occupy the subalpine level, where are found tree species: *Fagus silvatica*, *Picea abies*, *Carpinus betulus, Betula pendula, Acer pseudoplatanus, Ulmus montana, Frasinus excelsior, Acer campestre, Pinus mugo*. The herbs species from this area are represented by: *Poa pratensis, Calamagrostis epigeios, Juncus inflexus, Tussilago farfara, Viola odoratum, Alium ursinum, Carex sp., Cirsium arvense*.

3. MATERIAL AND METHODS

The researches were carried out at a bauxite quarry located in Zece Hotare, Bihor County. The exploitation of bauxite ended in 1998. In 2004 and 2005 very large works were started for setting up the levelling and acacia (*Robinia pseudocacia*) tree planting on the levelled area as well as spruce tree (*Picea abies*) on the slope area.

The acacia (*Robinia pseudocacia*) and spruce tree (*Picea abies*) saplings were planted at 1 m distance on every row, and at 2 m distance between rows. The dimensions of the hole were 40 x 40 x 40 cm, and 6.0 kg of manure was used for each hole. In order to ensure a high rate of plant development were watered with 16 litres of water each.

On the hillside of the quarry, the mattress was made out of oak stakes and beech rods at 2 meters distance in order to prevent soil erosion, (Fig. 1).

Figure 1. Beech tree (*Fagus silvatica*) mattress after being set up (2004), in the former bauxite quarry from Zece Hotare, Bihor

The way that vegetation came to ground was studied in the experiment that had the objective of determining the influence of fertilization on the growth of acacia (*Robinia pseudocacia*) tree. The study was located in the upper third level of the previous quarry and had the following variants: V_1= Control, no fertilizer; V_2 = $N_{120}K_{120}$ (24 g complex fertilizer/hole); V_3= Manure 30t/ha (6 kg/ hole); V_4 = Manure 30 t/ha (6 kg/ hole) + $N_{120}K_{120}$. The experiment was placed using the block method in 4 replications. Every plot had a number of 20 plants. After being planted, each sapling was watered with 16 litres of water, which ensured a 95% success ratio. Annual growths were determined for 40 plants in each variant (10 plants x 4 replications).

The experimental data was processed using the variation analysis method, (Ciobanu, 2004, Domuța, 2006 b).

In order to determine the physical and chemical properties of the soil from the previous bauxite quarry at Zece Hotare and the properties of the soil from the limitrophe beech tree (*Fagus silvatica*) forest (682 m altitude), 4 soil profiles were placed on the levelled area, on the high area (667 m altitude), and on the low area (665 m altitude), on the hillside with a 10% slope (672 m altitude), on which spruce was planted, without any mattress and in the beech tree (*Fagus silvatica*) forest at 50 m distance from the edge. The samples for enzymatical analysis were taken from 10 to 10 cm in the same areas. The determinations took place in one laboratory of the Agricultural Research and Development Station Oradea.

The physical properties were determined on the soil samples taken in a natural layout from the 4 profiles by using cylinders of 100 cm^3 each (Φ=50 mm, h=51 mm) in 5 replications. These cylinders were used to determine the bulk density and the hydraulic conductivity, following the soil sciences laboratories methods, (Domuța, 2006 a, Ciobanu et al. 2008).

The determinations of humus, phosphorous and mobile potassium were made using regular methods described by Samuel (2003). The dehidrogenase and phosphatase activity was determined using the method described by Drăgan – Bularda (1983). The catalase activity was determined using the permanganometer method (Samuel, 2003). The urease activity was determined using the method presented by Kiss et al. (1989).

The soil from the beech tree forest (*Fagus silvatica*) is a skeletic calcareous Preluvosol and in the former bauxite quarry it is a Erodosol argic decosol Rhodic argic.

4. RESULTS AND DISCUSSION

4.1. Physical properties

4.1.1. Granulometric characteristics

The highest values of the coarse sand, fine sand and the total silt were registered in the profile from limitrophe beech tree (*Fagus silvatica*) forest and the lowest values were registered on the hillside of the former bauxite quarry, (Tab. 1).

Colloid clay had the lowest values in the beech tree (*Fagus silvatica*) forest, 38.5%, in average for all four depths. The colloid clay content in the previous bauxite quarry is 89.1% higher on the side, with 71.2% higher in the profile located in the high levelled area and with 67.8% higher in the profile from the low levelled area, (Tab. 1).

Table 1. Textural composition of the land in the previous bauxite quarry from Zece Hotare, and in the limitrophe beech tree (*Fagus silvatica*) forest

Depth – cm	Coarse sand >2.0 mm	Fine sand 2.0-0.2 mm	Silt 0.02-0.002 mm	Clay <0.002 mm
	(%)			
Profile 1 – limitrophe beech tree (*Fagus silvatica*) forest				
0-17	3.3	28.1	33.9	34.7
17-30	3.0	21.8	32.7	42.5
30-40	2.4	25.9	32.7	39.0
40-60	2.3	18.1	41.3	38.3
Average	2.8	23.5	35.2	38.5
Profile 2 – high levelled area from former bauxite quarry				
0-17	2.3	12.6	19.5	65.6
17-30	2.6	13.0	22.9	61.5
30-40	2.0	13.7	21.1	63.2
40-60	1.8	14.4	15.7	68.0
Average	2.2	13.4	19.8	64.6
Profile 3 – low levelled area from former bauxite quarry				
0-17	2.9	11.9	19.8	65.4
17-30	2.8	11.5	21.5	64.2
30-40	2.0	12.6	20.6	64.8
40-60	1.8	14.0	15.0	69.2
Average	2.38	12.5	19.22	65.9
Profile 4 – hillside area from former bauxite quarry				
0-17	2.2	11.3	15.6	70.9
17-30	2.1	10.9	14.9	72.4
30-40	1.7	10.2	14.7	73.4
40-60	1.8	10.1	13.2	74.9
Average	1.95	10.63	14.6	72.82

4.1.2. Bulk density

The values of the bulk density in the levelled area are lower than the values determined in the limitrophe beech tree (*Fagus silvatica*) forest. The values determined in the profile from the hillside of the previous bauxite quarry are the highest. The differences are significant and distinctively (significant statistically) at the 0 – 60 cm depth on the soil from the beech tree (*Fagus silvatica*) forest in the high and low levelled area, while on the slope of the former quarry the differences were positive, very significant statistically, (Tab. 2).

4.1.3. Total porosity

The values of total porosity determined in the levelled area of the former bauxite quarry are higher than the values registered in the soil profile from the limitrophe beech tree (*Fagus silvatica*) forest. The lowest values of the total porosity were registered on the hillside of the former bauxite quarry. The differences registered (statistically significant) in the former quarry compared to the soil from the limitrophe beech tree (*Fagus silvatica*) forest are similar to those registered in the bulk density area but have an opposite meaning.

Table 2. Values of the bulk density, total porosity and hydraulic conductivity in the former bauxite quarry from Zece Hotare and in the limitrophe beech tree (*Fagus silvatica*) forest

Depth (cm)	Profile 1		Profile 2		Profile 3		Profile 4	
	Value	%	Value	%	Value	%	Value	%
Bulk density (g/cm^3)								
0-17	1.28	100	1.13	88	0.96	75	1.36	106
17-30	1.30	100	1.10	85	1.09	84	1.59	122
30-40	1.27	100	1.20	94	1.13	89	1.65	130
40-60	1.32	100	1.21	92	1.16	88	1.86	141
Average	1.29	10	1.16	90	1.09	84	1.62	125
LSD 5% 0.10; LSD 1% 0.19 LSD 0.1% 0.38								
Total porosity (%)								
0-17	52	100	58	111	64	123	49	94
17-30	51	100	59	116	59	116	40	78
30-40	53	100	55	104	58	109	38	72
40-60	51	100	55	109	57	104	30	55
Average	53.5	100	56.75	106.0	59.5	111	39.25	73
LSD 5% 2.1 LSD 1% 3.6 LSD 0.1% 8.5								
Hydraulic conductivity (mm/h)								
0-17	6.4	100	7.6	119	10.6	166	4.5	70
17-30	4.7	100	5.4	115	8.1	172	2.1	45
30-40	1.9	100	2.5	132	4.7	247	1.3	68
40-60	1.5	100	2.0	133	3.8	253	1.4	93
Average	3.63	100	4.38	121	6.8	187	2.33	64

LSD 5% 0.5 LSD 1% 1.3 LSD 0.1% 3.7. LSD-limit standard deviation. Profile 1 – limitrophe beech tree (*Fagus silvatica*) forest, Profile 2 – high levelled area from former bauxite quarry, Profile 3 – low levelled area from former bauxite quarry, Profile 4 – hillside area from former bauxite quarry.

4.1.4. Hydraulic conductivity

In comparation with the registered values within the soil profile from the limitrophe beech tree (Fagus silvatica) forest, were registered differences between 15% and 33% in the profile from the high levelled area, between 66% and 153% in the profile from the low levelled area. In the profile located on the hillside of the former bauxite quarry, the differences were negative (between – 7% and – 55%). Compared to the soil from the limitrophe beech tree (*Fagus silvatica*) forest, at the 0 – 60 cm soil profile, the hydraulic conductivity increased significantly in the high levelled area of the former bauxite quarry, distinctively significant statistically in the low levelled area and is lower and without any statistical significance on the hillside of the former bauxite quarry, (Tab. 2).

4.2. Chemical properties

4.2.1. Reaction

The soil from the limitrophe beech tree forest is characterized as low acid in the top 0 – 17 cm of the soil profiles and very acid with the depth. The pH values indicate a very acid reaction in the profiles from the former bauxite quarry, (Tab. 3)

Table 3. Values of the pH, humus, mobile phosphorus and potassium in the former bauxite quarry from Zece Hotare, and in the limitrophe beech tree (*Fagus silvatica*) forest

Depth -cm-	Profile 1		Profile 2		Profile 3		Profile 4	
	Value	%	Value	%	Value	%	Value	%
pH								
0-17	6.00	100	5.50	91.6	5.60	93.3	5.30	88.3
17-30	5.60	100	5.40	96.4	5.50	98.2	5.25	93.8
30-40	5.50	100	5.30	96.3	5.40	98.2	5.20	94.5
40-60	5.20	100	5.00	98.0	5.20	100.0	5.10	98.0
Average	5.58	100	5.4	96.7	5.42	97.1	5.21	93.4
LSD 5% 0.2 LSD 1% 0.5 LSD 0.1% 1.2								
Humus (%)								
0-17	3.7	100	0.38	10.3	0.47	12.7	0.13	3.5
17-30	2.9	100	0.26	8.9	0.28	9.7	0.00	0.0
30-40	1.1	100	0.00	0.0	0.00	0.0	0.00	0.0
40-60	0.4	100	0.00	0.0	0.00	0.0	0.00	0.0
Average	2.02	100	0.16	7.9	0.19	9.3	0.03	0.9
LSD 5% 0.16 LSD 1%0.35 LSD 0.1% 0.98								
Mobile phosphorus (ppm)								
0-17	9	100	3	30	4	44	2	22
17-30	8	100	2	25	3	38	2	25
30-40	4	100	2	50	2	50	1	25
40-60	2	100	1	50	1	50	1	50
Average	5.75	100	2.0	35	2.5	43	1.5	26
LSD 5% 0.72 LSD 1% 1.3 LSD0.1% 3.08								
Mobile potassium (ppm)								
0-17	135	100	50	37	65	48	40	30
17-30	95	100	40	42	50	53	30	32
30-40	70	100	30	43	40	57	15	21
40-60	30	100	10	30	15	50	10	30
Average	82.5	100	32.5	39	42.5	51.5	23.75	28.8

LSD 5% 2.74 LSD1% 4.61 LSD 0.1% 8.92

Profile 1 – limitrophe beech tree (*Fagus silvatica*) forest, Profile 2 – high levelled area from former bauxite quarry, Profile 3 – low levelled area from former bauxite quarry, Profile 4 – hillside area from former bauxite quarry.

In average, within the soil profile, the pH values are lower than the values determined in the beech forest which are 6.6% on the hillside, 3.3% in the high levelled area and 2.9% in the low levelled area of the former bauxite quarry. The differences registered in the levelled area are insignificant statistically and the difference registered on the hillside is very significant statistically.

4.2.2. Humus

The humus content of the soil from the limitrophe beech tree (*Fagus silvatica*) forest decrease within the soil profile from 3.7% at 0 – 17 cm to 2.9% at 17 – 30 cm, to 1.1% at 30 – 40 cm, up to 0.4% at 40 – 60 cm depth. In the former bauxite quarry the humus was found only between the depths 0 – 17 cm and 17 – 30 cm in the levelled area and at 0 – 17 cm depth in the hillside. In these three soil profiles of the former bauxite quarry, at 0 – 60 cm were registered major differences, very significant statistically, compared those from the limitrophe beech tree forest, (Tab. 3).

4.2.3. Mobile phosphorus

The content of mobile phosphorus at 0 – 17 cm is of 9.0 ppm in the soil from the limitrophe beech tree (*Fagus silvatica*) forest. In comparison with this one, in the soil profile from the depressionary levelled area of the former bauxite quarry the mobile phosphorus content had decreased with 64%, with 70% in the upper levelled area and with 78% on the hillside of the quarry. The mobile phosphorus content decreased with the depth. The differences registered at 0 – 60 cm soil depth in the soil profiles from the former bauxite quarry are very significant statistically, which are lower than 4.75 ppm in the limitrophe beech tree (*Fagus silvatica*) forest, (Tab. 3).

4.2.4. Mobile potassium

In the soil from limitrophe beech tree (*Fagus silvatica*) forest, the mobile potassium content is 135.0 ppm at 0 – 17 cm, 95.0 ppm at 17 – 30 cm, 70.0 ppm at 30 – 40 cm and 30 ppm at 40 – 60 cm. In all three profiles from the former bauxite quarry the potassium contents are low.

In comparison with the profile's average value (82.5 ppm) registered in the soil from beech tree (*Fagus silvatica*) forest, in the depressionary levelled area was registered a value with 48.5% lower. In the profile from the upper levelled area, the registered value is with 61% lower and in the profile from the hillside of the former bauxite quarry with 71.2%.

The mobile potassium content determined at 0-60 cm depth on the soil profile from the former bauxite quarry is lower than the content in mobile potassium determined in the limitrophe beech tree (*Fagus silvatica*) forest, (Tab. 3).

4.3. Microbiological and enzymatical activity

4.3.1. Actual dehidrogenase activity

The highest actual dehidrogenase activity at 0 – 10 cm depth (9.8 mg trifenilformazan/10 g soil) was registered in the soil from beech tree (*Fagus silvatica*) forest. The values of this activity decrease within the soil profile, (Tab. 4). In comparison with this profile, the closest values were registered in the profile from the depressionary levelled area (7.37 mg trifenilformazan/10 g soil). The difference between the average value of the profile and of the soil from beech tree (*Fagus silvatica*) forest is of 13.3%. In the soil profile situated in the upper levelled area the difference is of 27.9% and of 39.5% on the hillside of the former bauxite quarry. The actual dehidrogenase activity at 0 – 60 cm in soil profile compared to the one from the limitrophe beech tree (*Fagus silvatica*) forest decreased significantly in the soil profile from the hillside, distinctively significant statistically in the profile located in the upper levelled area and significantly statistically in the depresionary levelled area, (Tab. 4)

4.3.2. Acid phosphatase activity

The soil from limitrophe beech tree (*Fagus silvatica*) forest had the highest acid phosphatase activity. The average value on the soil profile is 0.263 mg fenol/g soil. The relative differences registered in the profiles from former bauxite quarry were of –41.4% on the hillside, of –34.6% on the profile from the upper levelled area and of –16.1% in the depressionary levelled area. The acid phosphatase activity at 0 -60 cm depth determined in the former bauxite quarry compared to the one from the limitrophe beech tree (*Fagus silvatica*) forest is insignificantly lower from a statistical point of view in the profile from the lower levelled area, and statistically significant lower in the high levelled area and very significantly statistically lower on the hillside, (Tab. 4).

Table 4. Microbyological and enzymatical activity determined in the former bauxite quarry from Zece Hotare, and in the limitrophe beech tree (*Fagus silvatica*) forest

Depth -cm-	Profile 1		Profile 2		Profile 3		Profile 4	
	Value	%	Value	%	Value	%	Value	%
Actual dehidrogenase activity (mg trifenilformazan/10 g sol)								
0-10	9.8	100	7.42	76	9.09	93	6.80	69
10-20	9.08	100	7.00	77	8.12	89	5.90	65
20-30	8.96	100	6.44	71	7.56	84	4.86	54
30-40	6.16	100	3.64	59	4.72	77	3.02	49
Average	8.50	100	6.13	72.1	7.37	86.7	5.14	60.5
LSD 5% 1.02 LSD 1% LSD 0.1% 3.30								
Acid phosphatase activity (mg fenol/g sol)								
0-10	0.352	100	0.188	53	0.281	80	0.164	47
10-20	0.294	100	0.179	61	0.269	91	0.130	44
20-30	0.209	100	0.141	67	0.183	87	0.090	43
30-40	0.195	100	0.125	64	0.150	80	0.060	31
Average	0.263	100	0.158	60.0	0.221	83.9	0.111	42.2
LSD 5% 0.040 LSD 1% 0.076 LSD 0.1% 0.131								
Catalase activity (mg H_2O_2/g sol)								
0-10	12.60	100	10.85	86	10.90	87	9.90	79
10-20	11.80	100	10.10	85	10.20	94	8.80	75
20-30	11.60	100	9.35	81	9.70	92	7.90	68
30-40	10.60	100	7.20	76	8.70	91	6.70	70
Average	11.65	100	9.38	80.4	9.88	84.8	8.33	77.5
LSD 5% 0.90 LSD 1% 1.56 LSD 0.1% 3.30								
Urease activity (mg NH_4/100 g sol)								
0-10	12.99	100	6.37	49	9.83	76	5.60	43
10-20	10.82	100	5.83	54	7.99	74	4.82	45
20-30	8.33	100	5.29	64	6.66	79	3.94	47
30-40	7.99	100	4.79	60	5.99	75	3.06	38
Average	10.03	100	5.57	55.5	7.62	75.9	4.36	43.4

LSD 5% 1.1 LSD1% 2.76 LSD0.1% 5.59

Profile 1 – limitrophe beech tree (*Fagus silvatica*) forest, Profile 2 – high levelled area from former bauxite quarry, Profile 3 – low levelled area from former bauxite quarry, Profile 4 – hillside area from former bauxite quarry

4.3.3. Catalase activity

Catalase activity of the soil from beech tree (*Fagus silvatica*) forest is the highest, in comparison with the average value, of 11.65 mg H_2O_2/g soil, on the profile. The values registered in the former bauxite quarry are lower with 22.5% in the profile from the hillside, with 18.6% in the profile from the depressionary levelled area and with 15.2% in the profile from the upper levelled area. From a statistical point of view, the differences in the soil from the limitrophe beech tree (*Fagus silvatica*) forest are distinctively significant statistically for the soil profiles from the levelled area and very significant for the profile situated on the slope.

4.3.4. Urease activity

The highest urease activity was registered in the soil from limitrophe beech tree (*Fagus silvatica*) forest. In comparison with the average value of the profile 10.03 mg NH_4/100 g soil, the following negative values of the differences were registered in the former bauxite quarry: of 56.6% on the hillside, of 44.5% in the depressionary levelled area and of 24.1% in the profile from the upper levelled area. Compared to the soil from the beech tree forest at 0 – 60 cm depth, the differences are very significant statistically in the profiles from the slope and on the upper levelled area which are significant statistically in the profile from the low levelled area, (Tab. 4).

Table 5. The average high of the acacia (*Robinia pseudocacia*) tree used in the planting and the influence of the fertilizers on annual growth in the conditions from former bauxite quarry

Variant	High		Differences		Statistical significant
	cm	%	cm	%	
In planting, 2005					
1. Control	25.0	100	-	-	Mt
2.$N_{120}P_{120}K_{120}$	26.7	106.8	1.7	6.8	-
3.Manure 6kg/hole	25.5	102.0	0.5	2.0	-
4.Manure 6kg/hole+ $N_{120}P_{120}K_{120}$	26.0	104.0	1.0	4.0	-
LSD 5% = 4.1; LSD 1% = 7.6; LSD 0.1% = 3.5					
In 2006					
1. Control	31.3	100	-	-	Mt
2.$N_{120}P_{120}K_{120}$	37.6	120.1	6.3	-	x
3.Manure 6kg/hole	36.0	115.0	4.7	-	x
4.Manure 6kg/hole+ $N_{120}P_{120}K_{120}$	46.4	148.2	15.1	-	xxx
LSD 5% = 3.9; LSD 1% = 6.6; LSD 0.1% = 13.0					
In 2007					
1. Control	40.3	100	-	-	Mt
2.$N_{120}P_{120}K_{120}$	49.8	123.6	9.6	23.6	xx
3.Manure 6kg/hole	50.6	125.6	10.3	25.6	xx
4.Manure 6kg/hole+ $N_{120}P_{120}K_{120}$	60.1	149.1	9.8	49.1	xxx
LSD 5% = 4.0; LSD 1% = 7.2; LSD 0.1% = 14.8					

4.4. The vegetation sowing in the former bauxite quarry

In the first year after acacia (*Robinia pseudocacia*) planting, the fertilizers determined a significant vegetation growth in comparison with the control in the variant with organic + mineral fertilization. The differences became significant with mineral and organic fertilization in the 2^{nd} years of the experiment. Both 2005 and 2007, very significant differences of the annual growths were registered in the variant with mineral and organic fertilization, (Tab. 5).

4.5. Planting of natural vegetation in the former bauxite quarry

In August 2006 the natural grass vegetation from the former bauxite quarry was represented by 13 plants /m^2 in the depressionary levelled area and the plants adapted for water excess were: *Juncus inflexus, Equisetum arvense*, *Polygonum persicaria*; *Tussilago farfara* and *Calamagrostis epigeios.*

In the high levelled area the number of plants decreased with 47% and their structure is changed. The works for the stabilisation of the erosion influenced very much the planting of the natural vegetation. The number of plants on 1 m^2 was with 133% higher in comparison with the variant without works against erosion where the natural vegetation was represented only by *Tussilago farfara,* (Tab. 6).

In August 2007 the number of plants/m^2 increased in all locations and new species appeared: *Cirsium arvense* and *Rubus caesius* in the low levelled area and *Hypericus perforatum* in the upper levelled area. *Cirsium arvense* appeared on the side with works against erosion and *Rubus caesius* on the side without works against erosion. The number of plants determined in April 2008 was higher than the number of plants determined in 2007 in all variants. The differences were of 34.7% in the low levelled area and of 16.7% in the upper levelled area. On the hillsides the differences were of 40% on the variant without works against the erosion and with 70% on the variant with works against erosion. *Alium ursinum* was identified in the limitrophe beech tree (*Fagus silvatica*) forest.

In the plateau area, but also on the hillside of the former bauxite quarry from Zece Hotare there is some spontaneous wooden vegetation: *Salix alb*, *Betula pendula*. There is *Fagus silvatica* in the limitrophe area of the beech tree forest, (Fig. 2).

Figure 2. Aspect with spontaneous wooden vegetation from former bauxite quarry from Zece Hotare, Romania, 2008

Table 6. Natural vegetation (plants/m^2) from different area of the former bauxite quarry from 2006 – 2008

Area	Total	Specie 1	Specie 2	Specie 3	Specie 4	Specie 5	Specie 6	Specie 7	Specie 8	Specie 9	Specie 10
2006											
A	13	3	-	-	-	1	-	-	3	3	3
B	7	5	1	-	1	-	-	-	-	-	-
C	3	3	-	-	-	-	-	-	-	-	-
D	8	7	-	8	-	-	-	-	-	-	-
2007											
A	27	5	1	-	1	1	-	5	3	5	6
B	12	8	2	-	1	-	1	-	-	-	-
C	7	6	-	-	1	-	-	-	-	-	-
D	8	-	-	8	-	-	-	-	-	-	-
2008											
A	35	7	1	-	1	1	-	7	4	8	6
B	20	10	4	-	3	-	3	-	-	-	-
C	16	14	-	2	-	-	-	-	-	-	-
D	12	-	-	9	-	-	-	-	-	-	3

A: Low levelled area; B: Upper levelled area; C: Hillside with mattress; D: Limitrophe beech tree (*Fagus silvatica*) forest. Specie 1: *Tussilago farfara;* Specie 2: *Cirsium arvense;* Specie 3: *Poa pratensis;* Specie 4: *Rubus caesisus;* Specie 5: *Calamagrostis epigeios;* Specie 6: *Hypericus perforatum;* Specie 7: *Equisetum arvense;* Specie 8: *Polygonum persicaria;* Specie 9: *Juncus inflexus;* Specie 10: *Alium ursinum*

5. DISCUSSIONS AND CONCLUSIONS

Researches carried out during 2005 – 2008 in the former bauxite quarry from Zece Hotare, Romania, led to the following conclusions regarding the physical, chemical and enzymatical properties of the land and the vegetation reconstruction.

The soil granulometric composition of these three soil profiles in the bauxite quarry is very different compared to the one in the limitrophe beech tree (*Fagus silvatica*) forest. The highest differences were registered in the colloidal clay content ($\Phi<0.002$). In average on the soil profile from the bauxite quarry compared to that from the beech tree (*Fagus silvatica*) forest the differences were of 89.1% on the hillside, 71.1% and 67.7% in the high and depressionary levelled areas.

The values for the bulk density, total porosity and the hydraulic conductivity of these three soil profiles from the bauxite quarry have the worst values compared to those from the limitrophe beech tree (*Fagus silvatica*) forest. The highest differences were registered on the hillside of the former bauxite quarry.

The soil humus content from the former bauxite quarry is lower than of the soil from the beech tree (*Fagus silvatica*) forest and was found only until a depth of 30 cm. The lowest values were registered on the hillside of the former bauxite quarry.

The values of the pH determined in the soil profiles from the former bauxite quarry are lower in comparison to those from the soil profile in the beech tree (*Fagus silvatica*) forest. The lowest values were those from the hillside.

The phosphorus and mobile potassium contents are very small in all 4 soil profiles. The lowest values were registered on the profile located on the hillside of the former bauxite quarry, and the highest values were found in the soil from the limitrophe beech tree (*Fagus silvatica*) forest.

The actual dehidrogenase activity had the lowest values on the soil profile located on the hillside of the former bauxite quarry. In average at the depth of 0-40 cm the differences in comparison with the determinated values on the soil from the beech tree (*Fagus silvatica*) forest (8.5 mg trifenilformazan/ 10 g soil in 24 hours) were of 39.5% in the profile from the hillside, of 27.9% in the profile located in the high levelled area and 13.7% in the profile in the low levelled area.

The acid phosphatase, catalase and urease activities are more reduced in the soil of the former bauxite quarry compared to those in the soil on the limitrophe beech tree (*Fagus silvatica*) forest. The highest differences were registered in the hillside of the former bauxite quarry.

The fertilization system used in planting the acacia (*Robinia pseudocacia*) in the levelled area of the former bauxite quarry is important because the organic mineral fertilization with 30t/ha manure and N_{120} P_{120} K_{120} determined the highest annual plant growth. Both organic (manure 30 t/ha), and mineral ($N_{120,}$ P_{120} K_{120}) determined significant statistically plant growth compared to the unfertilized "Control" both in 2006 and 2007.

The degree of coverage with grass vegetation in the former bauxite quarry grew from one year to another. In 2006, in the levelled area there were 13 plants/m^2 in the depressionary levelled area, 7 plants/m^2 in the upper levelled area, 8 plants/m^2 on the interval set up with mattress and 3 plants/m^2 on the hillside without stabilization works for erosion. In 2006 the number of plants in these areas increased to 23 plants / m^2, 14 plants /m^2, 75 plants/m^2 and 5 plants /m^2. In the spring of 2008 the lowest number of plants was registered in the hillside with no mattress, 7 plants/m^2, and the highest number, 31 plants/m^2 in the levelled low area, on the hillside with mattress there were 26plants/m^2, and in the high level area, 14 plants/m^2. In the limitrophe beech tree (*Fagus silvatica*) forest in the summer of 2006 and 2007 there were 8 plants/m^2 from the species *Poa pratensis*, and in the spring of 2008, 2 more plants/m^2 from the *Allium ursinum* specie.

In the plateau area, but also on the hillside of the former bauxite quarry from Zece Hotare are found some spontaneous wooden vegetation species: *Salix alb*, *Betula pendula* and *Fagus silvatica* in the limitrophe area of the beech tree forest.

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