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RECULTIVATION OF THE CAVITY OF THE CLOSED OPEN PIT BOR

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Abstract

Copper ore is one of the most important raw materials for industrial production. Increasing demands have been increasing its extraction generally. Shallow deposits with higher copper grade are mostly exhausted and the open pits become deeper, also the amount of overburden and the problems of its disposal are increased.

In some cases large quantities of overburden can solve the problem of recultivation of degraded areas. This is the case of recultivation of degraded areas on the location of the closed open pit Bor. Here, the overburden from another open pit, Veliki Krivelj, is disposed into the cavity of the open pit Bor. In this way the overburden is disposed without further area degradation and the cavity is primarily, technically recultivated. When the filling process is finished, waste depot will have a flat top at the level K+450 [2], which is above the neighboring terrain, and the slopes height will vary.

This problem was not especially considered up to date, so the experiences in this field are humble. This paper intends to be the basis for further research.

Key words: open pit, degraded area, recultivation, revitalization.

Introduction

Common model for solving the problem of the waste dump location choice is forming of the inner depot, if it is possible and rational.

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With the deepening of the open pit Veliki Krivelj, additional quantities of overburden became a problem since the capacities of the existing waste depots were full. The solution was found in the cavity of the closed open pit Bor. After the filling process is finished, the waste dump will be recultivated.

Recultivation is performed trough three phases, preparatory operations, technical recultivation and biological recultivation [3]. All three phases are equally important for the successful revitalization of the ecosystem.

In this case, preparatory operations assume filling the cavity of the open pit Bor, formation of the finishing plane, construction of the access roads, earth digging from the borrow pit and its loading and hauling to the waste dump and digging the dibble holes.

Technical recultivation assumes immediate preparation for the biological recultivation, meaning earth spreading in the form of 10 cm thick layer on the surface of the waste dump since the disposed material has unfavorable pedological characteristics. The organic materials imported in this way will enable growth of vegetation planted in the biological recultivation phase.

Material and Methods

With the deepening of the open pit Veliki Krivelj, the problem of space for overburden disposal was appeared. That was the reason for the construction of the combined overburden hauling system which transports and disposes the overburden into the cavity of the closed open pit Bor. The maximal depth of the cavity is 400 m and its volume is 240 000 000 m^3.

In the first phase of disposal the waste dump will be formed with the top bench plane at the level K+435. In the second phase of disposal the waste dump will take its final form with the top bench plane at the level K+450 [5].

The beginning of the first phase of disposal is unique in the world because of the disposing height which is 400 m. During the first phase 440 000 000 t of overburden can be disposed. Since the long-term development program of Veliki Krivelj open pit assumes disposal of 27 500 000 t of overburden, the first phase will take 16 years to complete.

The top bench surface must be leveled by bulldozer several times since the terrain consolidation will result in bends and cracks formation on the surface. During the last year before the beginning of technical and biological recultivation, 8 m wide main road will be traced on the top bench plane together with two 5 m wide auxiliary roads perpendicular to the main road. The distance between auxiliary roads will be 350-400 m and, in this way, 6 recultivation fields will be formed (figure 1).

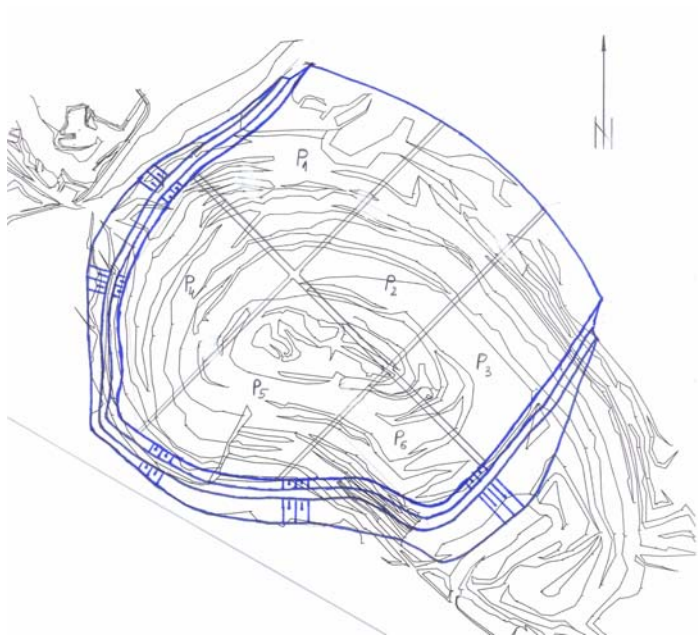

Figure 1 *–Final form of the waste dump and the road positions*

Results and Discussion

Earth and humus spreading will be done on the top bench plane (K+450) and on the bench K+435.

The humus is evenly spread on the surface in the thin layer. Even the grass will not be seeded, the humus from the borrow pit will trigger the spontaneous recultivation of the surface. The humus is also added into the dibble holes whose dimensions are 50x 50x50 cm. The amount of earth necessary for borrow pit is shown in table 1.

Table 1-Areas, number of dibble pits and the amount of needed earth

Location	Area (m^2)	Area without roads (m^2)	Number of dibble holes (pcs.)	The amount of earth from the borrow pit (m^3)	
				Spread (10 cm layer)	Added into dibble holes
Top bench plane	96 00 00	94 00 00	235 000	94 000	29 375
Main road	85 00 00	-	0	-	0
Auxiliary road	1 15 00	-	0	-	0
bench	4 05 00	2 70 00	5 400	2 700	675
Bench road	1 35 00	-	0	-	0
Total				**96 700**	**30 050**
TOTAL					**126 750**

Biological recultivation considers foresting. Since the top bench plane has large area, it is divided into six fields by roads construction. The roads will be used for material transport and maintenance and will stand as fire roads, so their width should be increased to 20 m after the soil is cultivated.

The choice of trees should consider trees with well developed root system, and trees that are highly resistant to waste soils, acidic reactions and are resistant to toxic gases and fumes since the waste dump is in the near proximity of smelting facilities and industrial complex. The chosen species

- black pine (Pinus nigra),
- locust tree (Robinia pseudoacacia),
- birch (Betula veruccosa),
- siberian elm (Ulmus pumila),
- silver linden (Tilia tomentosa) i
- maple (Acer negundo) [1], [4].

The trees will be planted as follows:

P_1 = 16,4 ha, culture of the black pine, 41 000 dibbles needed.

P_2 = 19,2 ha, mixed culture of birch and linden with linden content of 30 %, 33 600 birch and 14 400 linden dibbles needed.

P_3 = 17,2 ha, mixed culture of locust and elm with elm content of 30 %, 28 700 locust and 14 300 elm dibbles needed.

P_4 = 14 ha, mixed culture of birch and linden with linden content of 30 %, 23 300 birch and 11 700 maple dibbles needed.

P_5 = 18 ha, mixed culture of locust and linden with linden content of 30 %, 31 500 locust and 13 500 linden dibbles needed.

P_6 = 9,2 ha, mixed culture of elm and maple with maple content of 30 %, 15 300 elm and 7 700 maple dibbles needed.

On the bench plane at K+435 a mixed culture of black pine and linden is planted with linden content of 30 %. 3 780 pine and 1 620 linden dibbles are needed. Total number of dibbles is given in the table 2.

Table 2-Total number of dibbles

Culture	Black pine	Birch	Locust	Linden	Elm	Maple	Σ
Number of dibbles	44 780	56 900	60 200	29 520	29 600	19 400	**240 400**

The dibbles are planted in spring and autumn. Pine and maple are planted in spring, after the snow melts. Other species are planted in autumn just after the defoliation of vegetation.

Dibbles are planted into holes with square 2X2 m formation.[4]. The holes are partially filled with earth from the borrow pit and mixed with 2 kg of manure. When the roots are covered with earth, 100 g of fertilizer (NPK 15:15:15) is added into the hole.

The care about young plants consists of hoeing and harrowing in order to root out the weeds, during the first three years. Harrowing is performed in order

to prevent moisture loss and improve aeration. Replanting is done only if more than 20 % of the plants withered.

The greatest danger to the plants is forest fires so it is necessary to keep fire roads clean of vegetation.

Some of the chosen species are experimental since they have not been used in these conditions but have favorable recultivation characteristics

Conclusion

This paper gives the rational solution for the problem of closed open pit recultivation and the problem with the lack of space for waste and overburden disposal. Proposed solution aims to bring back reproductive quality to the degraded areas to the level that can, in some cases be better than the original.

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REKULTIVACIJA OTKOPANOG PROSTORA ZATVORENOG POVRŠINSKOG KOPA BOR

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Abstract

Ruda bakra zauzima visoku poziciju važnih sirovina za industrijsku proizvodnju, pa se zbog toga nameće potreba za njenom obimnijom eksploatacijom. Plića ležišta, sa bogatijom rudom, su iscrpljena pa zbog toga površinski kopovi postaju sve veći i dublji, a time se povećava i količina reskrivke, odnosno problemi vezani za njeno odlaganje.

Osim što je velika količina raskrivke problem ona u specifičnim slučajevima može da doprinese i smanjivanju degradiranih površina, odnosno da olakša rekultivaciju. Upravo takav slučaj je prisutan u Rudnicima bakra u Boru, gde je zatvoreni površinski kop Bor iskorišćen kao mesto gde se odlaže raskrivka sa aktivnog površinskog kopa Veliki Krivelj. Na taj način se rešavaju dva problema, tj. rešava se problem prostora za odlaganje raskrivke sa aktivnog površinskog kopa Veliki Krivelj, bez dodatog degradiranja zemljišta, i rešava se problem rekultivacije zatvorenog površinskog kopa Bor, s obzirom da se on zapunjava. Kada se završi proces zapunjavanja to će biti odlagalište sa ravanim platoom na koti K+450 [2], koje nadvisuje okolni teren, i bočnim kosinama promenljive visine. Rekultivacija ravnog platoa je neuporedivo laka od rekultivacije kosina površinskog kopa.

Za sada ova problematika nije posebno obrađivana, pa su i iskustva vrlo skromna. U tom smislu ovaj rad treba da posluži kao osnova za dalja istraživanja u toj oblasti.

Kljune reči: površinski kop, degradirano područje, rekultivacija, revitalizacija.

Rezime

Rešavanje problema rekultivacije degradiranog zemljišta koje je nastalo formiranjem površinskog kopa Bor je specifično jer podrazumeva najpre formiranje unutrašnjeg odlagališta od raskrivke koja se otkopava na susednom površinskom kopu Veliki Krivelj.

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Odnos zapremine otkopanog prostora i projektovane zapremine raskrivke je takav da će unutrašnje odlagalište nadvisiti okolni teren, odnosno njegov plato će biti na koti K+450 m.

Kada se završi formiranje unutrašnjeg odlagališta izvršiće se njegovo rekultivisanje u korišćenje uobičajenih ali i novih vrsta sadnog materijala. Zaštita zasada od eventualnog prenošenja požara je izvedena formiranje protivpožarnih puteva koji su orijentisani u odnosu na smerove duvanja dominantnih vetrova.

Ovako izvedena rekultivacija je neuporedivo laka i manje kota u odnosu na rekultivaciju kosina površinskog kopa. Pored toga na opisani način je rešen i problem odlaganja raskrivke sa površinskog kopa Veliki Krivelj bez degradiranja novih površina.

Summary

The solution for the problem of the areas degraded by forming of the open pit Bor and its specific recultivation, because it considers the formation of the inner waste dump extracted from the nearby open pit Veliki Krivelj.

The ratio of volumes of the pit cavity and designed overburden volume is such that the dump will be higher than the terrain with the top bench at the level K+450 m.

When the waste dump is formed, it will be recultivated using both custom and new plants. The fire protection of the fields will be ensured by fire roads perpendicular to the dominant wind directions.

The proposed recultivation is incomparably easier and cheaper than the recultivation of the open pit slopes. Beside previous mentioned, this proposal gives the solution for the problem of overburden disposal at open pit Veliki Krivelj.

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