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THE WASTE ROCK APPLICATION IN HYDRIC RECLAMATION

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Abstract

The evaluation of the impact of waste rock application in hydric reclamation of natural water-bearing subsidence troughs in the Karviná Region was carried out in sixteen localities where waste rock had been used in the past for the purposes of bank system improvement. Within the evaluation of waste rock impact on the hydrochemical character of water in the subsidence troughs the values of geochemical background were identified. In order to compare the impact of waste rock on the quality of water, changes in the hydrochemical parameters were monitored in the localities without waste rock banking, with partial (maximum ½ circumference) and complete waste rock banking.

Key words: *waste rock, water-bearing subsidence troughs, hydric reclamation, the Karviná Region*.

1. Introduction

The Karviná Region belongs among the most strained regions in the Czech Republic. With regard to the fact that coal mining is executed there by controlled caving without backfilling, there have been changes in the relief. Apart from the deformation of the ground which often leads to the impact on the original ecosystems, there are also changes in the regime of ground and surface water, microclimatic conditions, physical-chemical, physical and deformation properties which cause the destruction of human residence and underground services. The territories above cavities caused by extraction sink and subsidence troughs form, whose extent and rate of subsidence depends on the technology of mining, speed of advance, seam thickness, gob stowing methods, roof properties, etc. Water may accumulate in the formed depressions. In the past, such drainless basins – subsidence troughs were often the subject of extensive redevelopment works and served to found settling basins for flotation tailings and coal slurries. During surface redevelopment, waste rock has been generally used and thus morpho-logically very featureless land-scapes of up to several hectares have been made with limited capacities for revitalization. Redevelopment with further potential

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utilization of water areas had not been practically made use of as there had been efforts to restore devastated land resources, in the first place.

The process of subsidence trough formation in the Karviná partial basin of the OKR District has not been concluded and it shall be fading even after the termination of mining. Due to the impacts of the mining activities they may even deepen and widen. Recently, certain redevelopment-reclamation constructions (ARS) have been devised as hydric reclamation.

It is water quality which is a significant factor for the protection of natural water-bearing subsidence troughs. Water-bearing subsidence troughs are supplied by ground water and rainfall water. When compared to surface water, in the industrial landscape ground water is considerably less contaminated by pollutants and thus creates space not only for water and wetland biota, but also it participates in the increase in the biological balance in the territory. Therefore, water-bearing subsidence troughs may become an essential stabilization element of a seriously disturbed environment [1].

Based on the observed hydrochemical parameters, the main objective of the study was to evaluate the impact of waste rock which is frequently applied in hydric reclamation of natural water-bearing subsidence troughs in the Karviná Region.

2. Materials and Methods

The evaluation was carried out in the localities where waste rock had been applied for the purposes of bank system improvement in the past. For the purposes, the sixteen studied localities were divided into three groups in dependence on the extent of water area contact with waste rock (See Table 1).

Table 1. Classification of the monitored subsidence troughs in dependence on the contact of waste rock with water

Locality	Contact with waste rock		
	none	partial	full
Kozí Bezirk		Yes	
Ďáblík	Yes		
U lesa nad Bartošůvkou	Yes		
Bartošůvka		Yes	
Myškovec		Yes	
Velký Loucký rybník		Yes	
Ignačok		Yes	
Karvinský les		Yes	
Barbora			Yes
Větrná jáma			Yes
Panský stav	Yes		
Kostel sv. Petra z Alkantary		Yes	
Lanovka I.			Yes
Lanovka II.		Yes	
Kateřiny na Křivém potoce		Yes	
Mokroš			Yes

With regard to the fact that legislation does not give an unambiguous interpretation of waste rock as waste, its environmental characteristics were assessed according to the leachability tests. The values of the waste leaching test monitored parameters subject to the Notice (383/2001 Coll.) as amended, are below the limits of class I. Nevertheless, in some cases the analyses of surface and ground water interacting with waste rock show unacceptably high contents of certain components [2]. The main problem is intensely increased mineralization. Water seeping through heaps often have a natrium–sulphate character with mineralization in extreme cases of up to 7 $g \cdot l^{-1}$ with SO_4^{2-} content of over 4 000 $mg \cdot l^{-1}$.

3. Results and Discussion

In the localities where waste rock interacts along the overall water area there are prominently higher values of conductivity. In the localities which were in contact with waste rock only partially (maximum ½ water area) and water areas without any contact with waste rock no statistically significant difference has been registered.

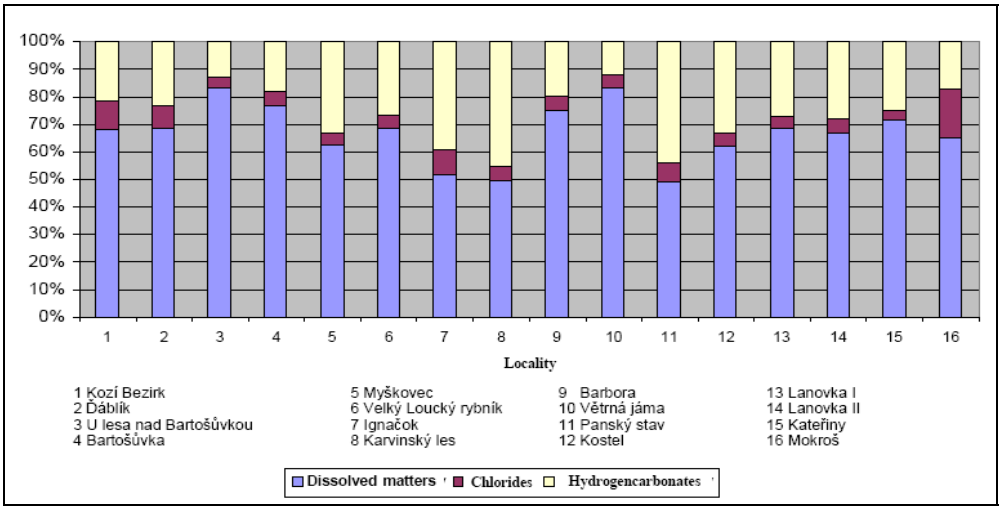

Figure 1. Percentage representation of hydrogencarbonates and chlorides in the dissolved substances

Evaluating the impact of waste rock on the conductivity and dissolved substances it was identified that the studied localities differ also within the individual groups. The range of conductivity for the localities whose water is in contact with waste rock along their circumference is from 74 to 288 $mS \cdot m^{-1}$. A much bigger dispersion of data (31 – 195 $mS \cdot m^{-1}$) is apparent in water areas which are in contact with waste rock only partially. The most homogenous set of data of the evaluated parameters (conductivity, dissolved substances) is demonstrated with the group of localities without any contact with waste rock (34 – 66 $mS \cdot m^{-1}$).

Hazardous for the environment in the evaluation of hazardous property H13 (Notice 376/2001 Coll.) is the conductivity value of 2 000 $mS \cdot m^{-1}$ (for water extract). Permanent damage – cell destruction due to the osmotic pressure occurs at the values of over 3 000 $mS \cdot m^{-1}$. The stated results imply that subsidence trough waters which are in full contact with waste rock have an approximately double conductivity than the remaining assessed locality groups, which however will not have an important influence on the water ecosystem.

In addition, hydrogencarbonates in the subsidence troughs demonstrate differences depending on the presence of waste rock. It was found out those water areas which are in contact with waste rock, either partially or in full extent, have a much higher content of hydrogencarbonates than the localities without any contact with waste rock.

It is well known that ground waters in the territories where waste rock had been applied have a hydrogencarbonate or sulphate character. With regard to the fact that the concentration of sulphates has not been identified on a regular basis, percentages of hydrogencarbonate and chloride anions in the dissolved substances were assessed (Figure 1). In three localities (Karvinský les, Ignačok and Panský stav) it can be assumed that hydrogencarbonates are dominant anions.

Assessing the waste rock impact on the hydrochemical parameters, it was discovered that the localities, in which waste rock had been applied along the overall circumference during redevelopment, have almost 2.5 times higher concentration of chlorides when compared with water areas that are in contact with waste rock only partially. Compared with the localities without any contact with waste rock it was up to 4.5 times higher (Figure 2).

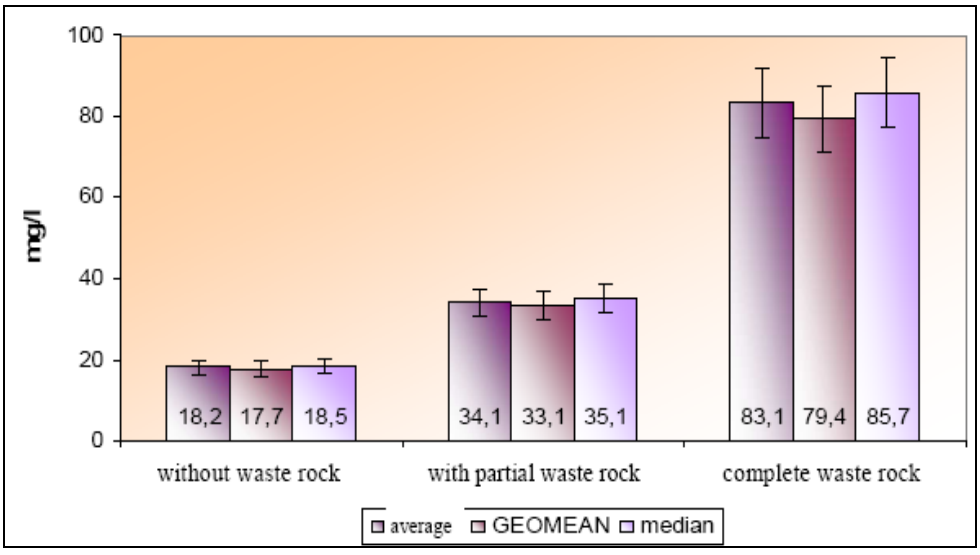

Figure 2. Waste rock impact on the chloride content

The highest chloride contents were identified in the locality of Mokroš and Lanovka I. The locality of Mokroš is influenced by leaching of chlorides that are in large measure represented in the slurries from coal preparation in the neighbouring locality of Nový York. The values of hydrogeochemical background for surface water stated in Table 2 were adopted from risk analyses for the locality of Nový York [2].

Table 2. Hydro-geochemical background for Mokroš (adopted from Raclavská, Grmela, 2006)

pH	Conductivity	RL	Ca	Mg	Na	Mn	Fe	Cl^-	$(SO_4)^{2-}$
	$(mS \cdot m^{-1})$	$(mg \cdot l^{-1})$							
7,33	112	885	86,38	28,13	134,23	0,20	0,71	126,5	319

With regard to the fact that during carbonate weathering calcium liberation is easier, it can be assumed that localities that have waste rock along their overall circumference shall have higher calcium contents. It is apparent from the obtained values that the water-bearing subsidence troughs with a dominant proportion of waste rock have almost double concentration of calcium than the remaining two assessed groups (Figure 3).

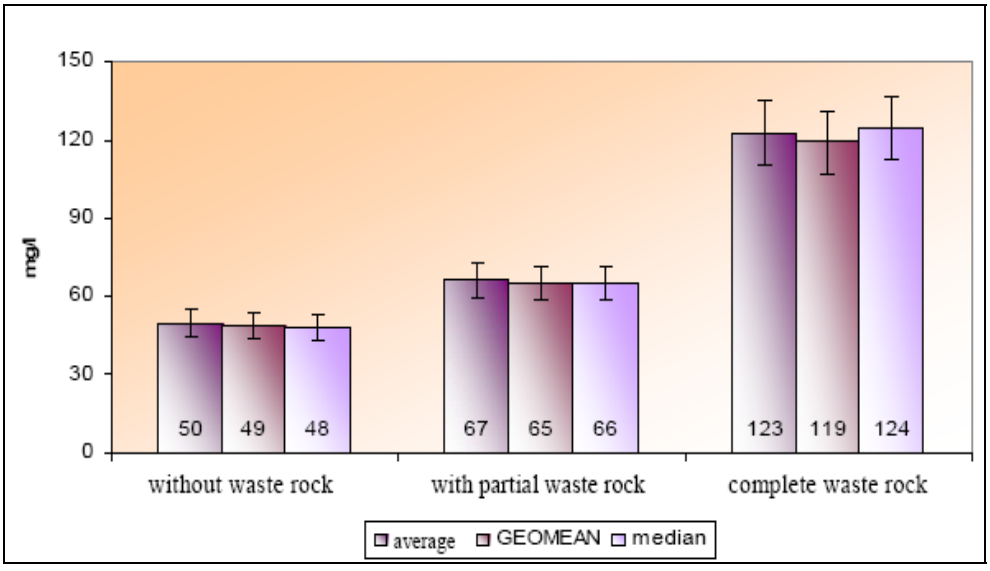

Figure 3. Waste rock impact on the calcium content

The case with magnesium is similar as apparent from Figure 4. However, in this case it cannot be clearly defined that the source of Mg^{2+} will be waste rock, which is also implied from Table 3, calculating the ranges of concentrations for

the classification of hydrochemical parameters of the subsidence troughs affected by the presence of waste rock. In all likelihood, the magnesium content will be of an organic origin and it shall penetrate the water system as a result of biomass degradation (chlorophyll). This fact would also be supported by the identified trend of magnesium content by the end of summer months and the beginning of autumn.

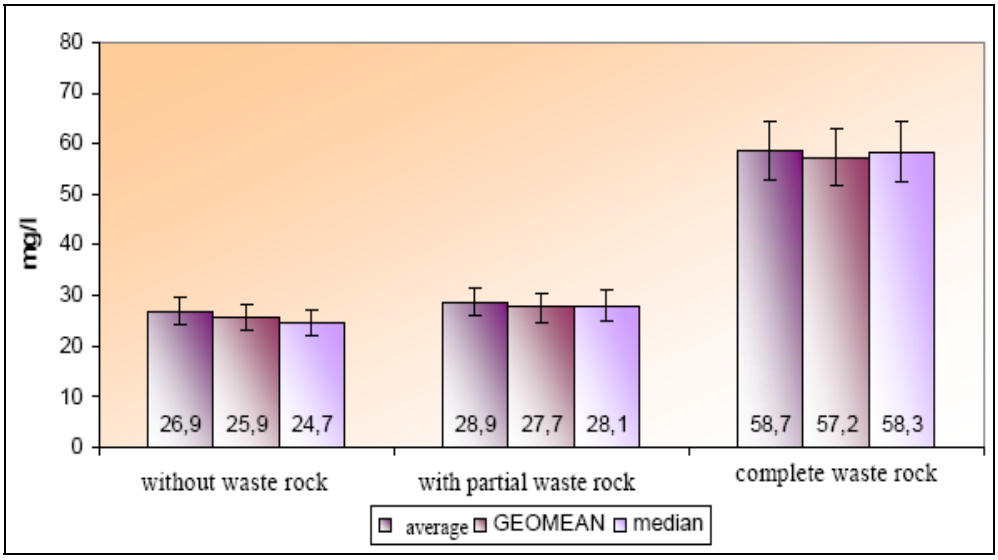

Figure 4. Waste rock impact on the magnesium content

Table 3. Concentration ranges for the classification of hydrochemical parameters of the subsidence troughs affected by the presence of waste rock

Hydrochemical parameter	without waste rock	<½ waste rock	full extent
Conductivity ($mS \cdot m^{-1}$)	33–60	45–112	117–284
Dissolved substances ($mg.l^{-1}$)	175–197	232–473	412–1510
$(HCO_3)^-$ ($mg \cdot l^{-1}$)	27–144	110–174	140–292
Cl^- ($mg \cdot l^{-1}$)	11–25	19–39	46–121
Ca^{2+} ($mg \cdot l^{-1}$)	31–70	49–74	68–177
Mg^{2+} ($mg \cdot l^{-1}$)	21–33	20–33	21–97

4. Conclusion

The value of the geochemical background (Table 3) is determined as an arithmetic mean adding or subtracting a standard deviation ($\bar{x}_i \pm \delta$). Table 3 implies that the water quality assessment criterion in the subsidence troughs based on the extent of applied waste rock is correct. In the selected parameters there are

significant differences among the individual groups with the exception of the above mentioned magnesium content. On the other hand, it is clear that in the observed parameters in no case there are higher concentrations which would significantly influence the water ecosystem.

It is apparent from the concentration ranges for the classification of hydrochemical parameters of the subsidence troughs affected by the presence of waste rock that the selected criterion for the water quality assessment in the subsidence troughs on the basis of applied waste rock extent has been correct. The identified correlations and percentage abundances of hydrogen carbonates and chlorides in the dissolved substances imply that in all the studied localities there will be more sulphate ions and cations Ca^{2+} and Mg^{2+} shall thus predominantly prefer the bond to an anion $(SO_4)^{2-}$. On the other hand, it is clear that in no case there is such higher concentration that would prominently influence the water ecosystem.

5. References

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