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Dewatering of waters from surface quarries in the Oltenia basin with the help of horizontal drilling

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Abstract. Dewatering involves reducing level of flooding of field by various technical measure. This paper studies the methods of dewatering involving reducing the level of flooding of field by various technical measure water from surface quarries with the help of horizontal drilling. Horizontal drilling does not cause discomfort at the level of exploitation works, transport and storage of deposits being a very efficient method. This has a great advantage both in terms of efficiency and the level of the environment because it eliminates land cover.

1 Introduction

The development of deposits of mineral substances and useful rocks requires prior hydrogeological research, to determine the inflow of water in the area of future exploitation, to take appropriate measures for digging mining works for opening and preparation and then exploitation and drainage which enter the work areas.

The inflow of water in the mining works is determined by several factors, among which are: the value of atmospheric precipitation, the structure of the hydrographic network, the position of the reservoir relative to the water level in rivers, the spread of impermeable cover deposits, the degree of flooding, hydrostatic pressure [1].

In general, the degree of flooding of a deposit is determined by the lithological composition and arrangement of the rocks, is the tectonic structure of the deposit.

The degree of flooding of a deposit is estimated by the size of the water flow coefficient, which is the ratio between the amount of water discharged and the production of profit made in a certain period of time, is the volume of water discharged per ton of profit made.

The dewatering of aquifers means all the measures for drainage and evacuation of water inside the formations of waste rock and useful mineral substances, to dig mining works and exploit the deposits in normal working conditions and safety of work and equipment used.

The dewatering of aquifers requires the construction of a complex of arrangements and drainage works for the interception and capture of groundwater, outside or even inside the

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field of exploitation, put into operation in a determined succession and located according to different scheme [1].

In the case of up-to-date operations, dewatering is required to begin, where possible, with approx. 2-3 years before the start of the opening, preparation and exploitation works, in order to ensure optimal conditions both for the actual excavation of the mining works and for the circulation of the equipment on the berms of the work and dump steps. Dewatering measures are characterized by methods, schemes, types and dewatering works.

2 Dewatering with horizontal drilling

It is practiced as a basic procedure or dewatering aid. The horizontal boreholes have maximum lengths of 100-150 m, a slope to the mouth of 2.5 ‰ and are made with special drilling rigs (fig. 1). The scope of horizontal boreholes is very wide, but it is best to apply for drainage of thin aquifer horizons. The length of the horizontal boreholes at the non-working edges of the quarries is determined by the condition of capturing the main part of the water stream beyond the potential surface of the landslide or the collapse of the step; at the working edges their length is taken 1,5-2,0 times longer than the excavation width of the excavator used.

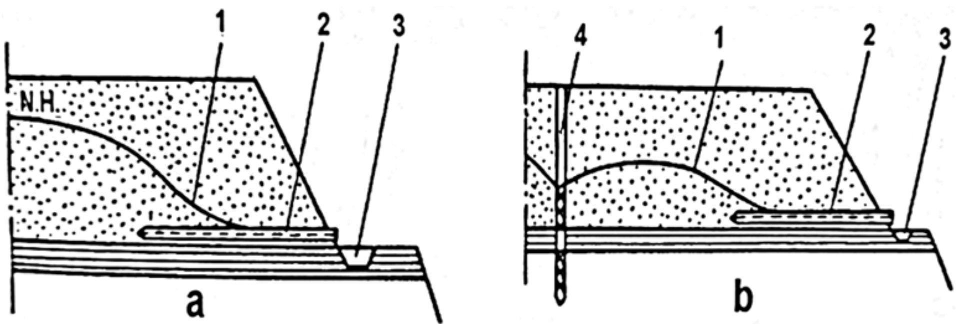

Fig. 1. Dewatering of quarry steps with horizontal drilling [1], a) use for dewatering only horizontal drillings; b) use for dewatering large diameter vertical drilling and horizontal drilling; 1-surface of groundwater; 2-hole horizontal probe; 3- ditch for draining water from the step; 4-diameter vertical drilling.

They are made with special drilling rigs both in the useful mineral substance and in the sterile aquifer rock, they are tubed and then equipped with metal, ceramic, polyethylene, asbestos-cement or glass-plastic filters. Often the boreholes on the berms of the steps prepared for operation or even in operation, are not tubed and thus function until their complete closure. The Russian-built MGB-2 installation was used to drill horizontal holes in our country. Drilling is done in five phases.

For drilling, rods were used that had a helical snail welded to them, which was used to extract detritus. [2-5].

At the end of the rods is the screed with a diameter of 60-80 mm that made the digging and advancing. Simultaneously with the advancement of the screed, guide tubes were attached to the rear, fig. 2.a.

Then unscrew the rods from the screed and take them out, fig. 2.b, after which the filter column was inserted, fig. 2.c. Further, the guide tubes were unscrewed from the screed and removed, fig. 2.d, thus leaving in the hole only the filter column ending in the screed fig. 2.e.

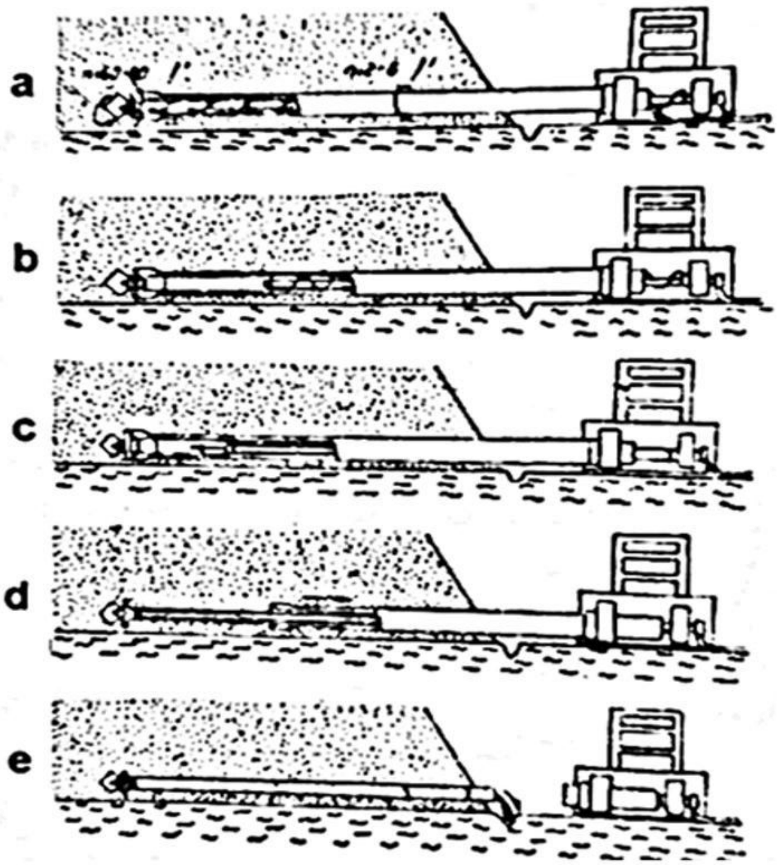

Fig. 2. Horizontal drilling execution scheme with MGB-2 installation: [1], a) drilling equipment, b) drilling column extraction, c) insertion of the filter column,d) extraction of the working column, e)horizontal drilling in operation.

Most of the times, the horizontal drilling drillings are performed on steps, in the work front, simultaneously with the excavation. They are executed with a length equal to the length of the operating block. The inflow of water to the horizontal boreholes can be calculated with the relation:

$$Q = \frac{2 \cdot q \cdot \sigma}{1 - \frac{2\sigma}{L} f_1\left(\frac{1}{2\sigma}\right)} \tag{1}$$

in which :
q - is the normal groundwater drainage module on 1.0 m of slope;
L - distance from the quarry slope to the supply limit, $f_1(1/2\sigma)$ function determined from table no. 1;
2σ - the distance between two boreholes.

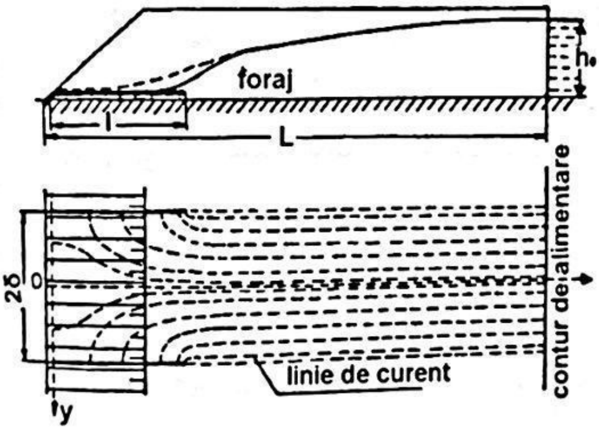

Fig. 3. Horizontal drilling (calculation scheme) [1].

Table 1. The correlation between the length of the boreholes and the distance between them.

1/2	0.25	0.50	1.00	1.50	2.00	2.50
$f_1(1/2\sigma)$	0.08	0.29	0.78	1.29	1.78	2.28

Horizontal drilling flow:

$$Q_s = Qf_2\left(\frac{1}{2\sigma}\right) \tag{2}$$

in which $f_2(1/2\sigma)$ is determined from fig. 4. The distance between the boreholes must not exceed (0.5-1.0) l.

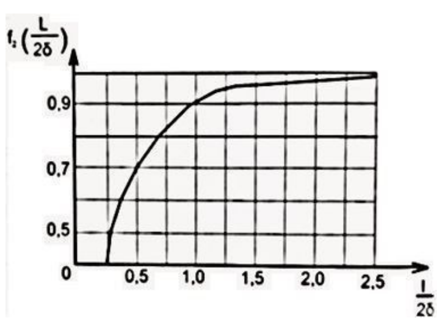

Fig. 4. Graph for determining horizontal drilling flows [1].

For the drainage of free level waters fed from infiltrations, the unitary flow per 1 m of drilling (q_0) is given by the relation:

$$q_0 = q \cdot 2a \tag{3}$$

The distance between the boreholes can be established with the relation:

$$2\sigma = 2\sqrt{\frac{K}{q}h_0^2} \tag{4}$$

Where h_0 is the maximum permissible height at half of the boreholes.

Height of water at a point on the depression curve (y) between boreholes, at a distance x:

$$l = \sqrt{\frac{q}{k}(2\sigma - X)X} \tag{5}$$

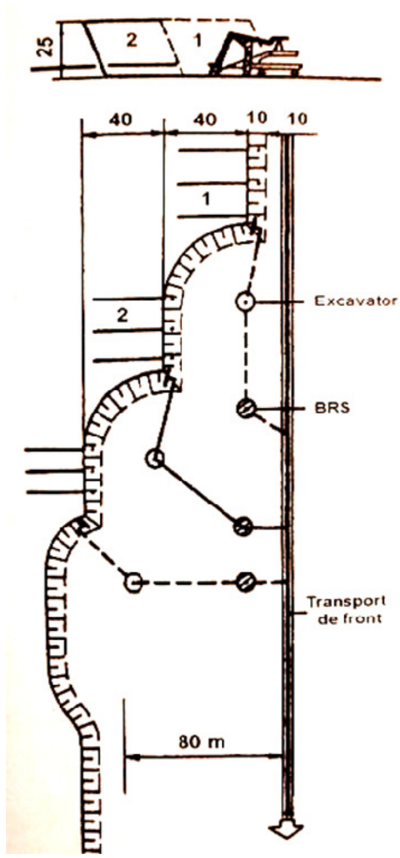

Fig. 5. Horizontal drilling drilling scheme for excavator ESR_C 1400 [1].

The mounting of the horizontal filters is done following the excavator working in the respective stage, for the block immediately following the one under excavation. It is recommended to use 90 mm diameter PVC pipes, which can be recovered when the excavator passes over them and do not pose a danger of breaking the excavator teeth like metal ones. The layout of the horizontal boreholes in the excavation with excavator ESR_C 1400 is given in figure 5.

If in that step the sand or aquifer is with the bed above 2m from the base of the slope, horizontal drilling cannot be performed. In this case, it is recommended to use boreholes inclined at 45-25^0, made from the upper step. In this case the drilling is performed with rods and tracking pipe.

Depending on the stratigraphy and the geometry of the quarry steps, these drillings can be performed even from another upper step, taking into account the limit depth of the FAC-50 installation of 50m and the inclination of the hole.

After the excavation, the hole is filled with gravel (30-50 mm in diameter) and then the follow-up pipe is extracted. Figure 6 shows the scheme of such drillings. [4-8]

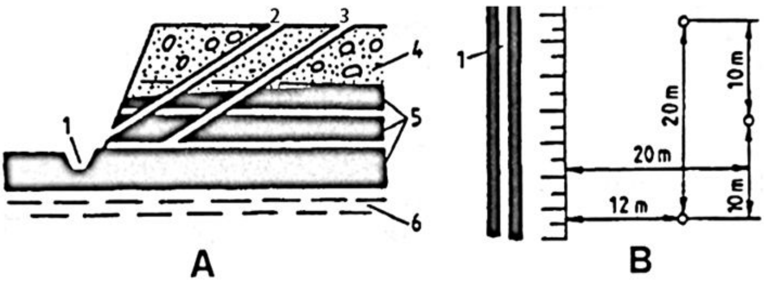

Fig. 6. Slope drilling scheme [1], A) section; B) plan view; 1- slope channel; 2- active inclined drilling; 3- inactive inclined drilling; 4- aquifer sand; 5-coal; 6-clay.

At the level of environmental protection, horizontal drilling technology is very efficient and has the great advantage of eliminating field excavations and works performed by horizontal drilling do not cause discomfort in rail or road traffic, also bypassing previous underground obstacles (pipes, cables and other).

The horizontal drilling method can be performed in almost any kind of terrain, being in accordance with the norms of environmental protection.

This technology is also ecological, because the soil resulting from the excavation will be stored so as not to affect the environment and the surroundings of the area.

The horizontal drilling technology guarantees the shortening of the execution term in relation to other technologies, still offering a precision of the works due to the way of following the work from the surface.

This method even has an execution cost 20-30% lower than other methods [6-8].

This paper studies the efficiency of horizontal drilling works in coal mines in the Gorj basin compared to other known drilling methods. The measurements were made during 2021.

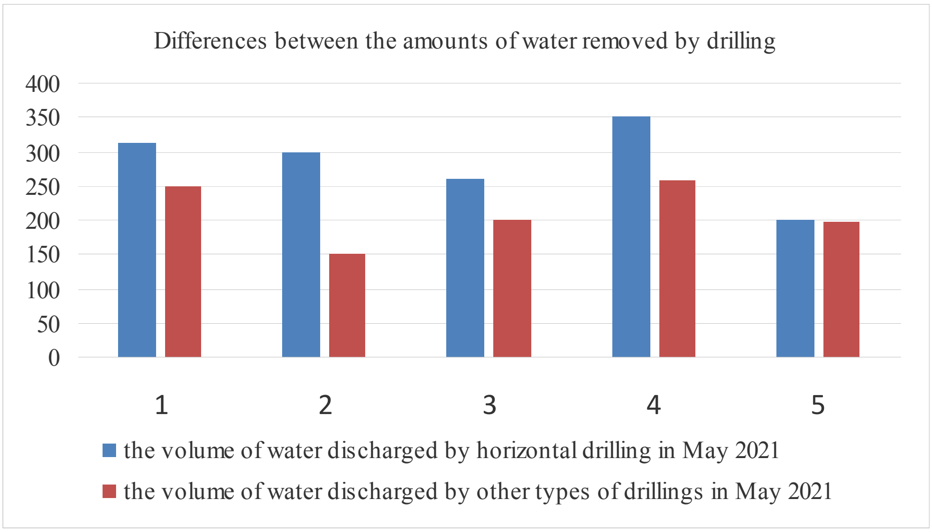

Fig. 7. Differences between the amounts of water removed by drilling in May 2021.

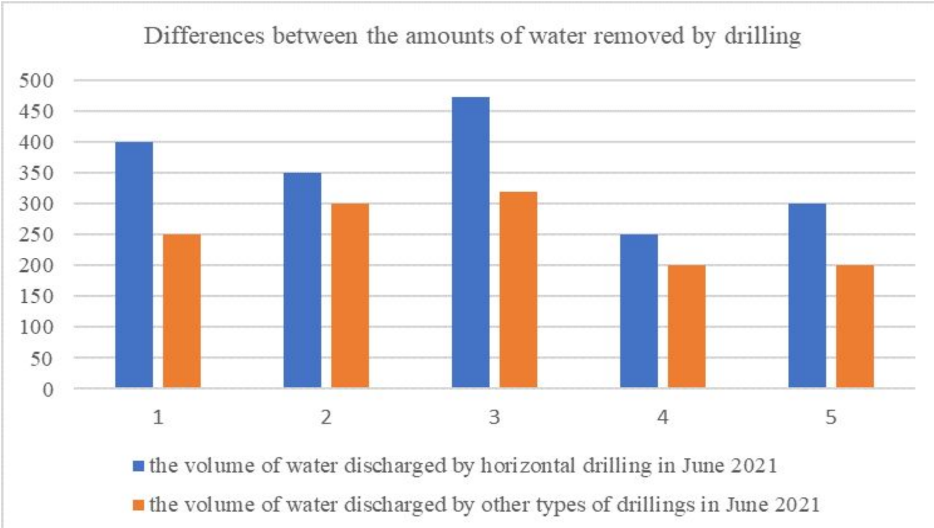

Fig. 8. Differences between the amounts of water removed by drilling in June 2021.

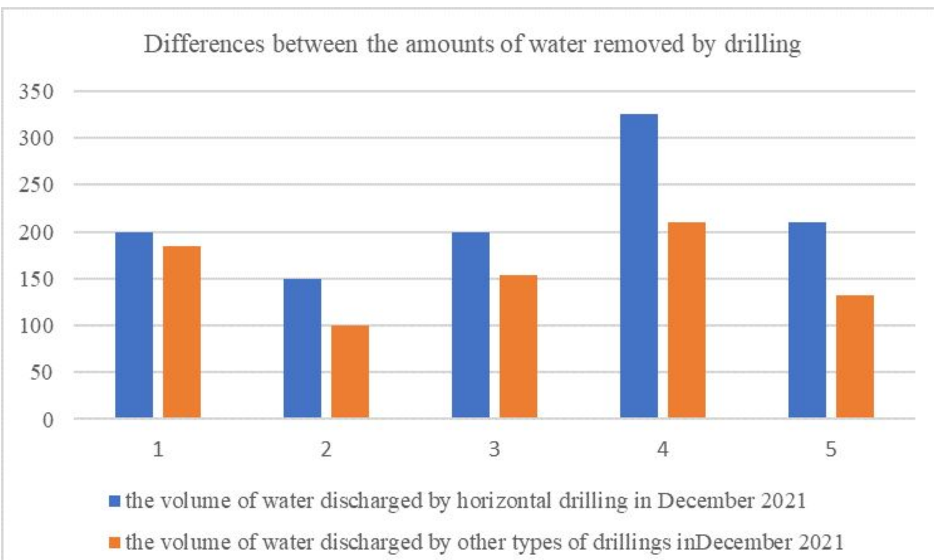

Fig. 9. Differences between the amounts of water removed by drilling in December 2021.

As we can see in the graphs presented in figures 7, 8 and 9, the amount of water discharged with the help of drilling is much higher in any of the months studied compared to the other extraction methods. Thus, with the help of horizontal drillings, we can also obtain quantities exceeding 300 m^3 / h.

3 Conclusions

As for the deposits that are exploited at the surface, they face both the problem of water from canvases and aquifers, and that of surface water. This is why the dewatering works play an important role in the technology of surface exploitation. In many cases, the inadequacy of this problem causes great difficulties in the normal exploitation of the deposits.

The deepening of the quarries, the attraction in exploitation of the deposits with hydrogeological and heavier conditions keep in present the problem of dewatering and necessitate its improvement. In this field, too, the experience gained in the quarries in Oltenia is useful, as the current exploitations here have had hydrogeological problems and have applied different solutions in concrete situations.

The need to execute in time and in good conditions the dewatering works at each perimeter and aquifer horizon appeared in the case of putting into operation the coal reserves, so as to ensure the full and optimal exploitation of the deposit.

From the perspective of the quality of the environment, the horizontal drillings are much more friendly with the environment, they do not produce its changes because no land excavations are made.

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