RELATION BETWEEN DEWATERING AND THE ACCOMMODATION OF HYDRAULIC FLYING-ASHES IN THE INNER SPOIL BANK /CLAY--SILT/ OF THE THOREZ MINE

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SUMMARY

At the beginning of the operation of the Thorez surface mine located on the southern slope of the Mátra Mountains, an intense dispute evolved in professional circles concerning the question whether the 2 million t/year quantity of slag and fly-ash, produced at the neighbouring Gagarin Thermal Power Plant, could be accommodated in the so-called inner spoil bank space by hydromechanization technology. Those opposing the hydraulic transportation of flying ashes were anxious about the different effects of the large quantity of water, getting into the inner spoil bank space, on the mine, on the stability of the slopes of the inner spoil bank, on the level and quality of of the neighbouring groundwaters.

On the basis of nearly 10 years' investigations and experiences, an up-to-date hydraulic flying ashes transportation system was developed at the Gagarin Thermal Power Plant, and in the inner spoil bank space the facilities, ensuring the conditions of the hydromechanization-type accommodation of flying ashes, together with the return water delivery system belonging to it were constructed. The hydraulic transportation system was put into operation in 1981 and the filling of the mine pit omitted in the inner spoil bank /pit "B" and the casette omitted in the upper segment /casette No.I/ with slag and fly-ash, carried there through pipeline, started.

The paper discusses the antecedents and investigations making possible the novel accommodation of flying ashes.

The Gagarin Thermal Power Plant and the Thorez Surface Mine are sitnated on the southern slope of the Mátra Mountais. /See Figure 1/. North of its area the andesite block of the Mátra Mountains is situated. The general slope direction of the area is NNW-SSE, where agricultural cultivation, viti-culture are pursued. This is indicated by the hallmarked settlement names: Visonta, Abasár, Domoszló; settlements of the Mátra region famous for its wine.

According to the geological description of the area [1],[2], at the foot of the Mátra Mountains the continuation of the andesite mass of the Mátra sunken to the depth is to be expected beneath the upper-Pannonian Sarmatian and even Tortonian deposit cover. The earlier research activities established that "near the southern edge of the Mátra Mountains, the lower-Pannonian deposit was entirely missing and the upper-Pannonian sediment transegrades directly on the Sarmatioan formation. The upper section of the filling of the basin at the foot of the Mátra and Bükk Mountains consists of greenish and grey clay, clayey marl, greyish and yellowish sand, as well as sandstone alternately, with the predominance of sandy members. The stratification is indicated also by the interposition of an earthy-woody brown coal deposit, the thickness of which frequently reaches several metres." /See Figure 3/A/.

The lignite deposits run along the southern edge of the Mátra Mountains without interruption, and for this very reason they were the subject of geological research activities and investigations for a long time.

The research activities and investigations - besides the determination of the lignite stock - are concerned also with the conditions of its exploitation, with its optimal technological solution. The result of these mining-geo-hydrological research activities and investigations was at the time of the opening of the surface mine that the apper-Pannonian lignitious-sandy sediment of the regions of Visonta became one of the best-explored areas of the country from a hydrogeological point of view.

According to the detailed description of the area, the substratum of the region consists of tertiary cavern water--storing rocks and clay slates, on which Eocene, Oligocene, Miocene, Pleistocene and Holocene sediments are deposited in different thickness. It can be said that the Eocene layers - in the northern part of the Great Hungarian Plain - are vertically impermeable. The generally wide-spread Oligocene layers, reaching even 500 m thickness, form a continuous protective layer between the substratum and the sediments deposited subsequently.

At the foot of the Mátra Mountains, the lower-Pannonian layers are missing. Here, the upper-Pannonian layers were deposited directly on the andesite - in the form of slate clay and lignite deposits. These clays, clayey marls, but also the lignite itself are primarily fresh-water formations.

The NE-SW and NW-SE slope of the lignite deposits can be unequivocally established from the geological sections. Eight lignite layers of different thickness can be found in the stratification described to 150 m depth, the majority of the intermediate layers is sand having good or medicore water conductivity, occasionally a little silt or clay.

In the course of the research activities mentioned in the foregoing, the detailed explorations - since here the aim was the safe dewatering of of the surface mine pit planned to be of 60-80 m depth - were completed by detailed hydrogeological investigations and calculations which extended not only to the immediate region of the mine areas but to their wider regions as well.

It was proved by the investigations that communication in a vertical sense is not possible between the individual impermeable layers. In the aquiferous layers, on the other hand, a parmanent water flow can be shown in the direction of the Great Hungarian Plain, the supply of which is provided through the layer heads coming to the surface and by the precipication water presumably seeping in from the direction of the Mátra Mountains. The seepage of the precipitation water - investigating the water balance - takes place primarily during the winter hydrological half-year and mostly along the water courses. 40 % of the contact surfaces of the Pleistocene -Pannonian layers is good aquiferous rock, thus seepage, the water supply of the individual aquiferous layers is not impeded.

In this region having a surface sloping in N-S, NW-SE direction - in the triangle included by villages Visonta, Domoszló, and Markaz - is opend the open-cut, surface lignite mine.

In the dewatering of the working pit, the geological circumstances already discussed are optimally utilized when dewatering is solved partly by the pumping-out of the water of the Pannonian sand layers having good water conductivity, partly by draining it into the sand layers deposited beneath the planned level of working, having a relatively lower /or reduced/piezometric pressure. In practice, this means that a row of water wells draining several aquiferous layers simultaneously are built and put into operation on the boundary line of the surface mine field to be opened, establishing such a network of drop wells, inside the field at the same time, whose wells drop the water into the aquiferous layer beneath the working surface by gravity. By this method it is possible to dewater the opened mine field safely and to make the working of the mine unimpeded from such a point of view.

In consequence of dewatering, a significant part of the water contained in the soil mass situated within the working limits of the mine and removable by gravity left the soil; practically the soil mass of the depressioned body desiccated. This soil mass having much less water content than the natural one /which can be said practically to be dry/ is massed parallel with the exploitation of the inter-stratified lignite layers in the already exploited part of the mine pit, in the so-called inner spoil bank. /See Figure 2/B/. Expecting a subsequent consolidation, the surface of this is usually higher than the original, surrounding ground level and it has a rather disorderly, divided surface. Its mass has been mixed thoroughly, which means that in this soil mass heaped up loosely /without compacting/, all soil varieties can be found in the most unexpected succession from the highly impermeable eich clay, through the sand fraction, to the coarse boulder. The firing residue produced in the power plant - the approximately 1,5 million m^3/year quantity of fly ash in a dry state - also got into this heaped-up soil mass.

The transportation of the dry fly ash and its mixing with the refuse coming from the mine have caused many operational -technical problems during the approx. 10 past years of operation. We do not want to detail them here, we only want to illustrate their significance by the fact that the power plant has tried to find a solution to change over to the hydraulic transportation of flying ashes since 1974, demonstrating the actual economic justification of this changeover as well.

The investigations and studies made at this time formulate the technical conditions of the transportation system of flying ashes, which can be briefly characterized as follows:

- it is necessary to make the transportation of flying ashes independent of the transportation system of the mine refuse;
- the flying ashes should be accommodated in the inner spoil bank space of the mine;
- the hydraulic transportation system must transport a dense mixture;
- it is necessary to provide for the recycling of the transportation water getting into the inner spoil bank space and for the prevention of the harmful environmental effects of the groundwater.

On the basis of these requirements we worked out in 1975 the flying ashes accommodation programme of the power plant which, however, meets a great resistance, especially in professional circles.

The dispute is caused primarily by the fact that not knowing the composition and permeability of the material of the spoil bank, the experte do not consider the stability of the different slopes of the inner spoil bank safe if a large quantity of water gets into the spoil bank that is, in their view, the mine working is endangered. It was also the subject of dispute whether the settling pool of the hydraulic spoil bank will be formed on the surface of the inner spoil bank and whether the hydraulic transportation system will receive water from this, or all transportation water will run off and it will be necessary to produce the transportation water from an external water reserve or from wells.

The questions under dispute were answered by calculations or by preliminary experiments, then by large model experiments. After tests of laboratory character, we made experiments on the surface of the spoil bank. The experiments and tests were based on two pools formed in a model-like manner, on the observation wells sunk in their region and on the height observation system, on the joint operation and observation of these. The duration of the experiment was 6 months: from July 1, 1974 until the middle of December the two small cassettes were continuously filled with water, and the variations of the points of the height and water level observation network established in their region were observed until the middle of January, 1975. The geodetic subsidence of the points in the area of the pool approached 1500 mm /it was between 800-1100 mm on the average/, the subsidence of the observation wells located at about 20 m distance from the pool was 300-500 mm, but even the observation wells located at about 50 m distance subsided 100-200 mm.

With constant feeding of water /maintenance of water level/, the water appeared already on the eighth day in the observation wells located nearest to the pool /10-12 m/, and in the third month of the experiment /between the 65th and 75th experimental days/water was observed also in the most distant /50 m/ piezometer pipes.

As a final result of the experiment, it was found that the rate of the progress of the wetting front under the ground level was

0,14 m/day on the average at 8-10 m depth
0,26 m/day at 14-15 m depth
0,40 m/day at 20-30 m depth.

The conclusion was that in the inner spoil bank the soil becomes saturated relatively soon, therefore, the pools settling the flying ash-slurry are formed and the transportation water running off between the inner spoil bank-slope filled back in the mine can be conducted by a row of drop wells into the sand layer deposited under the working level in the interest of safe mine working.

As we have already mentioned, prior to mining, the surface mine pit is dewatered by a row of wells on two sides and by inner drop wells. When surface mining has already made some progress, the operation of the row of wells on the two sides becomes unnecessary, therefore, the outermost wells are intermittently stopped. Only those NW wells remained near the western surface mining which were utilized for other purpose as well in the meantime /as drinking water acquisition sources/. By placing the hydraulically transported sag and fly-ash on the inner spoil bank it is necessary to give an answer to the question whether the transportation water coming into the inner spoil bank influences the water discharge and water quality of the wells.

On the basis of hydrogeological analogues, it is certain that the water discharge of the wells increases. There is no reason why the chemical state of the water should unfavourably change, unless the hardness of the water will increase to a small extent.

Enclosures No [1] and [2] show the possibility of the storage of flying ashes in the inner spoil bank space, which solves the final storage of about 45-50 million m^3 of flying ashes. Figure 3 illustrates the designed slope of the flying-ash dumping ground which is quite identical with the hydromechanization developed at other power plants - with the solution of the flying ash dumping-grounds.

The solutions discussed satisfy the conditions of technical and economic significance planned by the thermal power plant, at the same time it will be possible to control the water circulation of the inner spoil bank increased by the transportation water of flying ashes.

On the basis of the several years' operating experiences of the system it will be possible to determine, to interpret the water balance of the water circulation of the inner spoil bank and the hydraulic transportation system of flying ashes, moreover to compare them with the calculations made in the course of designing.

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LEGENDS

Figure 1

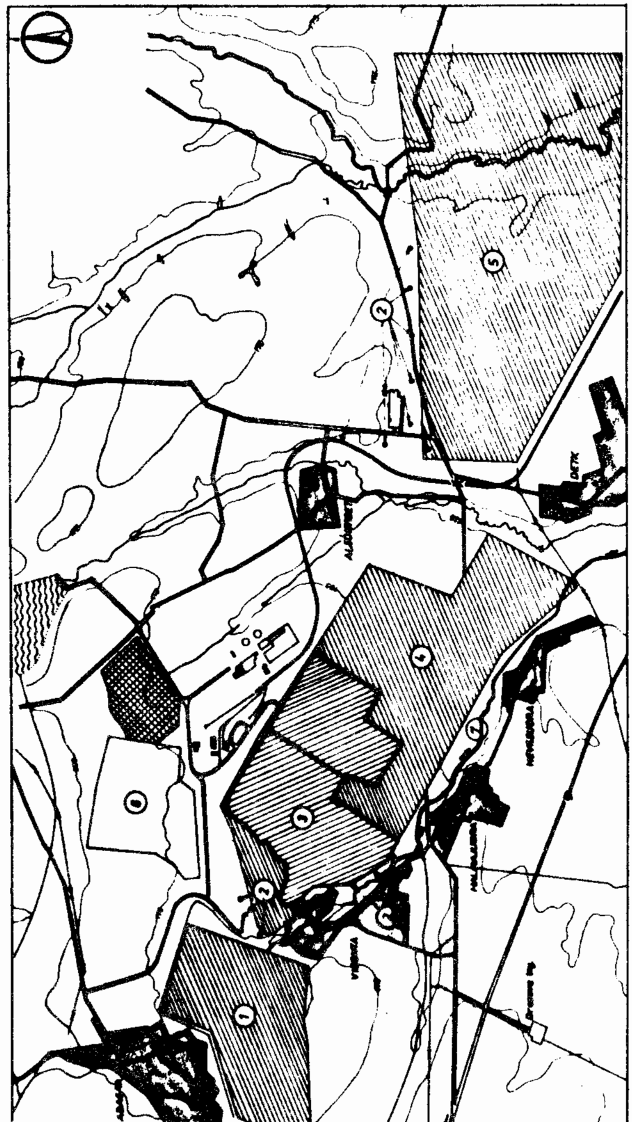
1. Western surface mining
2. Dewatering wells
3. Designed hydraulic spoil-bank
4. Eastern I. surface mining
5. Eastern II. surface mining
6. External spoil-bank
7. Bene-brook

Figure 2

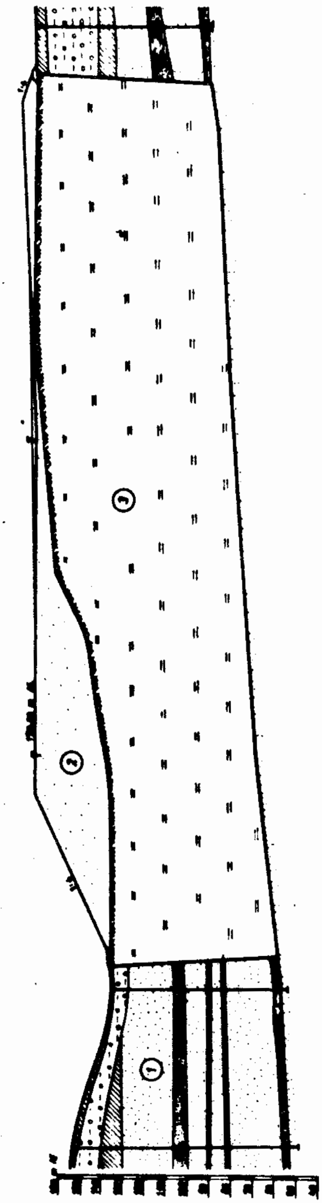
1. Original stratification
2. Flying ashes
3. Inner spoil-bank /clay-silt/

Figure 3

1. Bene-brook
2. Forest belt
3. Water well
4. Outflow trench
5. Initial bank /soil/
6. Grass protected slope
7. Slag bank
8. Observation well
9. Drain
10. Freatic line
11. Flying ashes
12. Inner spoil bank /clay-silt/
13. Absorbing columns
14. Pipeline



1. ábra – figure 1.



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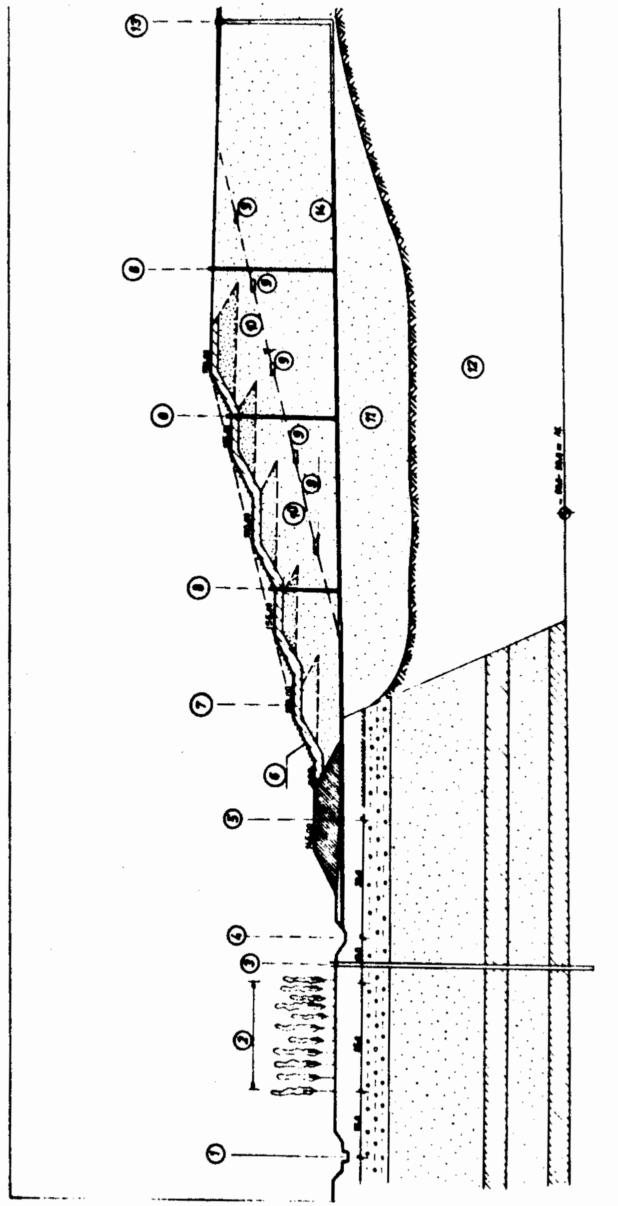

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