The geological methods and resultats of the preliminary dewatering of the water-bearing layers in environment of coal seams in Borsod Brown Coal Basin

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Summary

In the paper we make known the localization, the boundaries of the Borsod Coal Basin, the geological structure of its coal seam groups, the thickness of the secondary protectiv clayish rock and sand layers of the coal seams, their thickness variation, and rock physics characteristics.

The sand layers have water supply, and contain stressed plane of ground water. We make known the functional system of the layers. We define the rate of danger of the ground water on the basis of the specified data and documentations. We permanently do the dewatering in advance of the water-hazard mines.

We describe the known relations those we design the dewatering /the yield, the number of the walls, the distance of the wells one from another, the time of dewatering/ with. These calculated data are confirmed by the practical obsevations. We discuss the placement of the filtering wells in the roadways, the method of their countersink and filtering, and the erection of the wells observing the stratum water.

We observe the troubles these have influenced the design and effectuation. We count the things to be done which can contribute to better erection of dewatering / the enlargement of the diameter of the wells, the effort to make a complete well/ to increasing by the effectiveness. A complete well means that the water-bearing layer is dilled through totally, and the pipe in that layer is fitted with filter.

Borsod Brown Coal Basin /Figure 1./ is situated on the eastern part of North Hungary. The character of the basin is determined by the mountains representing the boundaries or rather by their continuations under the surface./In the south is Bükk mountain, in the north are Szendrő and Rudabánya moutains./ The floor formations /Oligocen, recently determined Under Miocen/ shows the boundaries of the coal seams in the west. /Here the end of the coal seams is caused by erosin./ The brown coal basin is open in the east. The coal seams come the an end in the direction of the deep-sloughs respectively of the paleotypal sea.

The coal seams occuring are formed in the Helvatian substage /recently named Ottnangien substage/ of the Miocen age. [3]

The serie of strata of the coal seams /Figure 2./ -that the coal seams and the secondary rocks developed in- that we will deal later with, is well distinguished from the floor and the roof formations. Its floor is so-called under riolit tuff /tufit, green clay/ which is developed on the total area of the basin. Its roof is younger formations /Tortonien substage, recently named Badenien substage/ which mainly are tufacoeus as well. The serie of strata of the coal seams is incomplete in most places /mainly in the west/, because a part of these has been denuded by erosion. It facilitates, increases the water supply of sand layers. Its thickness is between 20-400 m.

We know three seams in the west part, five seams in the east part of the basin in the Helvatien serie of strata. /All the five seams are not in the total area of the basin, because the coal forming process connected with the transgression or the regression is moved away in the west in the northerly direction, in the south in the eastward direction. The thickness of the coal seams is between 0,8-12 m. /This time no more than 3 m thick coal section - excepting Ormos Colliery - is stripped, and more than three seams being under the others will be not stripped in the future, too./ We identify the Third seam in the west basin with the Fifth seam in the east basin.

The serie of strata of the coal seams is formed by brown coal, clay, clayey marl, rock flour /aleurit/, sand and their transitional rocks: sandy clay, dawk etc. [4] Often clayey formations are found accompanied by the brown coal seams /excepting the Second seam/. The thickness of clayey formations is changing. We give an illustration of the isoline thickness map of the coal seams protectiv layers of a part of the south basin demonstrating the change of thickness. /Figure 3./. The sitmation is more unfavourable in the west basin in respect of the protectiv layers, because there are some places /e.g. the Second coal coal seams in Egercsehi, Farkaslyuk Collieries/, where either sand layer is located directly on the coal seam or they are separeted by some centimetres clayey formation. Thus we can say that the bigger part of stratum water infiltrates into the underground working places because of stoppage or petering of the protectiv layer in bigger part of the basin. Some rock physics characteristics of the protectiv layer:

Natural water content	26 - 31 %
Sand content	8,8 - 69 %
Density	2210 - 2380 kg/m³
Young's modulus	140 - 1350 MPa
Unidirectional compressive strength	1,3 - 12,5 MPa

/The smaller value is charasteristic of clay, the bigger one of aleurit/.

There are sand layers among the coal seams in the serie of strata of the coal seams. As we have seen the sand layers are located directly on the coal seams in some places, in other places they are above them with some protectiv interbedding. /We examine the sand layers in their position above the coal seams/. The number and thickness of sand layers changes /Figure 4./. A lot of sand layers have been developed where the interval between the coal seams is long /in case of the First and Second, Third and Fourth seam/. The ratio of sand layers in East Borsod Coal Basin is about 43 %, in the West Borsod Coal Basin is about 55 % on average.

Stucture of sand layers are inhomogeneous. We can observe regional /considerably/ and local changes. The regional changes have coarse granular structure. The local changes in the development caused them turning into clay or the interbedding of clay /clayey rock/ pocket. Previously we could not separate them, today /on the basis of geophysics profiling/ they are separable.

We add the granulometric composition curve of sand discovered Feketevölgy I. Colliery to show the average granular structure of the sand layers. The rock physics characteristics of the sand layers provide an opportunity for dewatering in advance. There is stressed plane stratum water in the sand layers, their dynamic water plane is slightly lower in the vallies, than the groundwater level. But positive layer pressure system occurs, too. The water plane in the hills follows roughly the configuration of the terrain of the surface, but it is slightly flatted. /The water planes are relatively in deep position.

The structural disturbances /faults/ bear a significant part in the movement of strata water. It broke the aquiferous layers, moved them away from their original position, it narrowed down the water-course space, surface. But it made hydraulic contact in the layers being one above other. This hydraulic contact shows up only regionally in natural /primer/ condition, because some faults are impermeable - as we observed - and they only become aquiferous effected by the movements in consequence of coal worked out.

The expectable formations have water supply. The lateral water supply through the strata basset is bigger than the vertical infiltration. The supply can originate from karstic water or ground water. In general, we can determine the places of water supply and direction of the flow.

The most significant case of the strata communication system is, when the aquiferous layers /in a position formed by the erosion/ in the presence of a coal seam contact better the aquiferous layers /karst, gravel/, and they are in higher position, the ground water is compressed in consequence of this. There is a case, for instance, in the Sajo valley. /Figure 6./

The plane of dewatering is need the determination of the filtration factor. We make it, if it is possible, with water production in the geological research and in the mining, too. The value of the filtration factor is mainly 10^{-6} cm/s, rarely 10^{-5} cm/s.

The following data, documentations /with geophysics sections/, are at our disposal to the determination of the ground water-hazard:

1./ Drilling successive layers, and on the basis of these we make the followings:
   a./ isoline map of the thickness of the protectiv layer,
   b./ isoline map of the thickness of the sand layer,
   c./ tectonic map
2./ Levels of water. They are used to draw the isoline map of water level.

We draw the isoline map of the thickness of the specific protectiv layer collating the data 1. and 2. and the maps.

We use the rock physic characteristics for distinguishing the layers determining their water-leading capacity.

We counted our working collieries by water-hazard on the basis of XIII. Chapter, Water inrush of ÁBBSz /General Mining Safety Rules/. Half /6/ of our 12 working collieries are water-hazard according to Rules. These are Farkaslyuk, Putnok, Királd, Feketevölgy, Szeles and Edelény.

We permanently unwater our water-hazard collieries, and reduce the stress from the roadways drived for the purpose of mining.

Minig water was 59,95m³/minute pumped from the Borsod collieries on the 1st of July 1981. 66,6 % of that water is pumped from water-hazard collieries. In 1980 we drill 427 drainage holes 4211,5 m long for dewatering.

The main developing roadways are perpendicular to the faults according to the fault situation /the strike of the faults is north-east - south-west and their characteristic is such as a trough, an upthrust/ in Borsod Coal Mines /in the working collieries of Borsod Coal Mines/. The preparation of the stopes occurs in the intermediate space of faults. So the length of the logwall faces comes mainly about the frequency of faults. In 1980 the lenght of the logwall faces was

between 41 - 124 metres. 70 - 80 m long longwall faces were most typical. Borsod Coal Mines produced 5,3 million tons coal in 1980, 42,1 % of the production came from water-hazard collieries. The size of the worked out area was 2,29 square kilometres.
Water hazard very rarely appears in the form of water in-rush /at strata water 200-800 l/minute/ in the collieries of Borsod basin, but it delays the pace to drive drifts. Dripping water in longwall workings caused a decrease in strength of the secondary rocks in consequence of sinking into the floor the powered supports and the cutting machines. The infiltrating water keeps back the better output per manshift in the stopes. The output per man-shift in the stopes can decrease 25 % under the effect of dropping water.

So the chosen dewatering methods have to be such which decrease the stress or the water level on big area as far as possible that the drift driving or the stope can occur in a depression space.

We are concerned with a lot of dewatering versions in the Borsod Coal Basin. These are:

- a. roadways
  - a_1. roadways driven in the roof of coal
  - a_2. dewatering by provoking stope
- b. drilling
  - b_1. dewatering by inclined roof wells
  - b_2. dewatering by floor wells
  - b_3. dewatering by compressed air pressed in vertical roof wells
  - b_4. dewatering by wells drilled from the surface
  - b_5. dewatering by vertical roof wells.

About these a special lecture will be delivered about the dewatering by wells drilled from the surface and its resultats. We are not concerned with the estimation of the results of the different dewatering method by vertical roof wells proves simplest, most effective and most economical among the underground dewatering methods. For the time being we adopt alone this, so we are concerning with a detailed account of the design, working method and efficiency of this.

We determine the following data for the dewatering plan :

1. We calculate the water discharge according to the relationship Dupuit - Thien as a function of time.

$$Q = 1,36.k \frac{h_2^2 - h_o^2}{\lg \frac{R_t}{r_e}} \qquad 1.$$

where

h_2 the height of water column after release of stresses /m/

h_o the remaining water column /m/

R_t the distance as a function of time /m/

ϱ_e the equivalent radius of the area

We determine the water discharge as a function of the number of the established wells, too.

$$Q' = 1{,}36.\ k \frac{h_2^2 - h_3^2}{\lg \frac{R}{\varrho /N/}} \qquad 2.$$

where

h_3 the water level in the well relating to the floor of the strata

R then distance action belonging 6 moths

$$\varrho /N/ = \sqrt[n]{r_o \cdot 1 \cdot 2 \cdots n^{-1}} \qquad 3.$$

where

r_o the radius of the well

The water discharge derives from the collation of the two values.

2. The relation mentioned below gives the number of the necessary wells.

$$N = B \frac{q_{max}}{q_t} \qquad 4.$$

q_t the water discharge of a filter-hammered roof well which we determine with the graphic method of Scmieder, A. as a function of the permeability coefficient, the piezometric pressure of the strata, and the diameter of the well.

B = 1,2 safety factor

3. If we established wells all in the roadway surrounding a longwall working the distance of the wells derives from the relation mentioned below.

$$x = \frac{2\ /L+b/}{N} \qquad 5.$$

4. The time of dewatering /release of stresses/ derives from the relation mentioned below.

$$t = \frac{\varrho^2}{2,25\ a^*} \exp \left| \frac{4 \cdot K \cdot M \cdot sp}{Q_o} \right|$$

where

$a^* = \frac{k \cdot H}{n_o}$ piezo-elektric-conductivity /m²/sec/

H = piezometric pressure

n_o = free porosity

We can calculate the time of dewatering, too, but it is not necessary in the mining industry /only there, where the time of dewatering is longer, than the optimal discovered coal resourches respectively the area determined on the basis of other respects/ therefore we determine it on the basis of the optimal discovery.

The wells necessary for dewatering - on the basis of calculations, which have been verified by experiences - are 14-30 metres apart. The time of dewatering is 18-26 months. The water is produced from the water-bearing sand layers in the roof by the drainage wells /fitted with filters/ drilled into the roof. The filtering wells are drilled from the developing roadways oftenest 18-23 m from one another. /Figure 7./ We make an effort to limiting by wells an area as big as possible at the same time /adjecent 3-4 coal panels/. But this is determined by panels developed or prepared by roadways. Would be good to increase the area of the developed coal fields so dewatering of the longwall faces would be more economical.

If we know the direction of water flow we decrease the distance of the wells at right angles to the direction. We increase the distance of the wells in roadways drived beside longwall faces.

We have a lot of type drilling rigs /Craelius MY 40, SzEK-1, MDR-03 and MDR-06/to drill the roof wells. In the future we will standardize them for the MDR drilling rigs after wearing out the old rigs. The diameter of the wells is 100 millimetres. The Figure 8. shows the shematic sketch of drilled wells.

We know from experience that we can make wells without locked boring head till 2-2,5 metres/bar water pressure in our roof sand layers. If the pressure is higher the roof drainage bore hole is drilled with locked boring head and cemented standpipe. The filter pipe is drived into sand layers because the sand wall is collapsible. We are not able or we should be able to do a complete well only very difficult in consequence of collapse. Generally, we are satisfied with putting some metres long filter pipe into sand layers.

Sometimes it is very difficult to drill a borehole because sand in large quantity can flow in through boreholes at some places. We defend ourself against it respectively we regulate it with locked boring head.

We use iron or synthetic filter pipes for dewatering in the wells.

The filter pipe made of iron is 63 millimetres diameter, it consists of 0,6-1,5 metres long pieces. Perforation is longitudinal or round holes. We use screening cloth or corrugated separator plate cover - depending on size of grain - to protect the filter pipe against clogging. At present we use it rarely because synthetic pipe superseded it because of its advantageous quality and economical usefulness.

Synthetic pipe applied as a filter pipe is similar to iron pipe. But the joint of the pipe pieces was worked out with shrinkage junction.

Catch and diversion of water brought out of mining places creates trouble.We try to make use of water produced from isolated mining places.[1]

We began the development of our observing system of ground water in the mines to make the plane of dewatering more accurate, and to study the efficiency of dewatering.

In the future we should like to progress in particulars mentioned below of the plane and effectuation of dewatering.

a. We have observed the yield of the water drainage boreholechanges to a high degree. The cause of this is the grain composition, the free porosity of water bearing sand layers are changeable. We can show the change of the grain composition, the rough grainy lentiform sand by underground geophysical measuring. So we shall not locate the drainage wells equidistant from one another, but in a interspace. So we shall place the filter pipe in the rough grainy layers, and as a result we can increase the water yield of the wells and the amount of the produced water. We determine the section of a borehole where we have to place the filter to similarly by geophysical measuring.

b. We will increase the lenght of the filtering boreholes drilled into the water bearing sand layers. We strive to do a complete well.

c. We shall increase the diameter of the drainage wells and the inlet surface of the filters.

The dewatering method preceding the longwall workings, as stated above proved the efficiency in the Borsod basin.

Literature

1 Béla Balogh: Bányamüvelés során feltárt vizdus homokrétegek vizének hasznositása. Utilization of water springing forth a highly wate-bearing sand layer intersected in the course of mining. Bányászati és Kohászati Lapok Bányászat. No. 9. 1977.

2 Béla Balogh: Vizdus homokrétegek harántolásának tapasztalata. Experiences obtained when intersecting highly water-bearing sand layers. Bányászati és Kohászati Lapok Bányászat. No. 5. 1973.

3 Andrew Juhász, dr: A borsodi medence miocénkoru szénelőfordulásának bányászati vonatkozásai. Mining aspects of the Miocene coal deposits of the Borsod basin. Bányászati és Kohászati Lapok Bányászat. No. 9. 1966, pp: 585-593.

4 Andrew Juhász, dr: A kelet-borsodi barnaszénmedence vizföldtani viszonyai. Hidrological and geographical conditions of the brown-coal basin in East-Borsod. Bányászati és Kohászati Lapok Bányászat. No. 10. 1965, pp: 677-690.

5 Andrew Juhász, dr: Hidrogeológia. Hydrogeology. Akadémiai Kiadó. Budapest. 1976.

6 Dr. Schmieder, A. Dr. Kesserü, Zs. Dr. Juhász, J. Willems, T. Dr. Martos, F.: Vizveszély és vizgazdálkodás a bányászatban. Water-hazard and water economy in the mining. Müszaki Könyvkiadó. Budapest. 1975.

Figure 1.

Sketch map of Borsod Coal Mines area

1. Delimitation of the coal basin
2. Area of the working collieries

Figure 2.

Column section of the coal seam group of Borsod Brown Coal Basin

1. Eastern basin region
2. Western basin region
3. Surface soil
4. Clay
5. Gravel
6. Sandy clay
7. Tuff and rocks originated from tuff
8. Aleurit
9. Sand
10. Clayey gravel
11. Sandy gravel
12. Tuff rock with lignite band
13. Clayey marl
14. Limestone
15. Shale
16. Coal
17. Boundary of stratigraphic discordance
18. Sand with gravel
19. Clay with leaf residue
20. Sandstone, lentiform sand
21. Clayey coal, coaly clay

Figure 3.

Change of the protective layer thickness on the North region of East Coal Basin

1. Designed line of thickness
2. Supposed line of thickness

Figure 4.

Change of sand thickness on the North region of the East Coal Basin

1. Designed line of thickness
2. Supposed line of thickness

Figure 5.

Grain-size characteristics from the South Coal Field of Feketevölgy I. Colliery

1. Sand
2. Sand flour

Figure 6.

Hydraulic model of the groundwater supply

1. Clay
2. Sand

Figure 7.

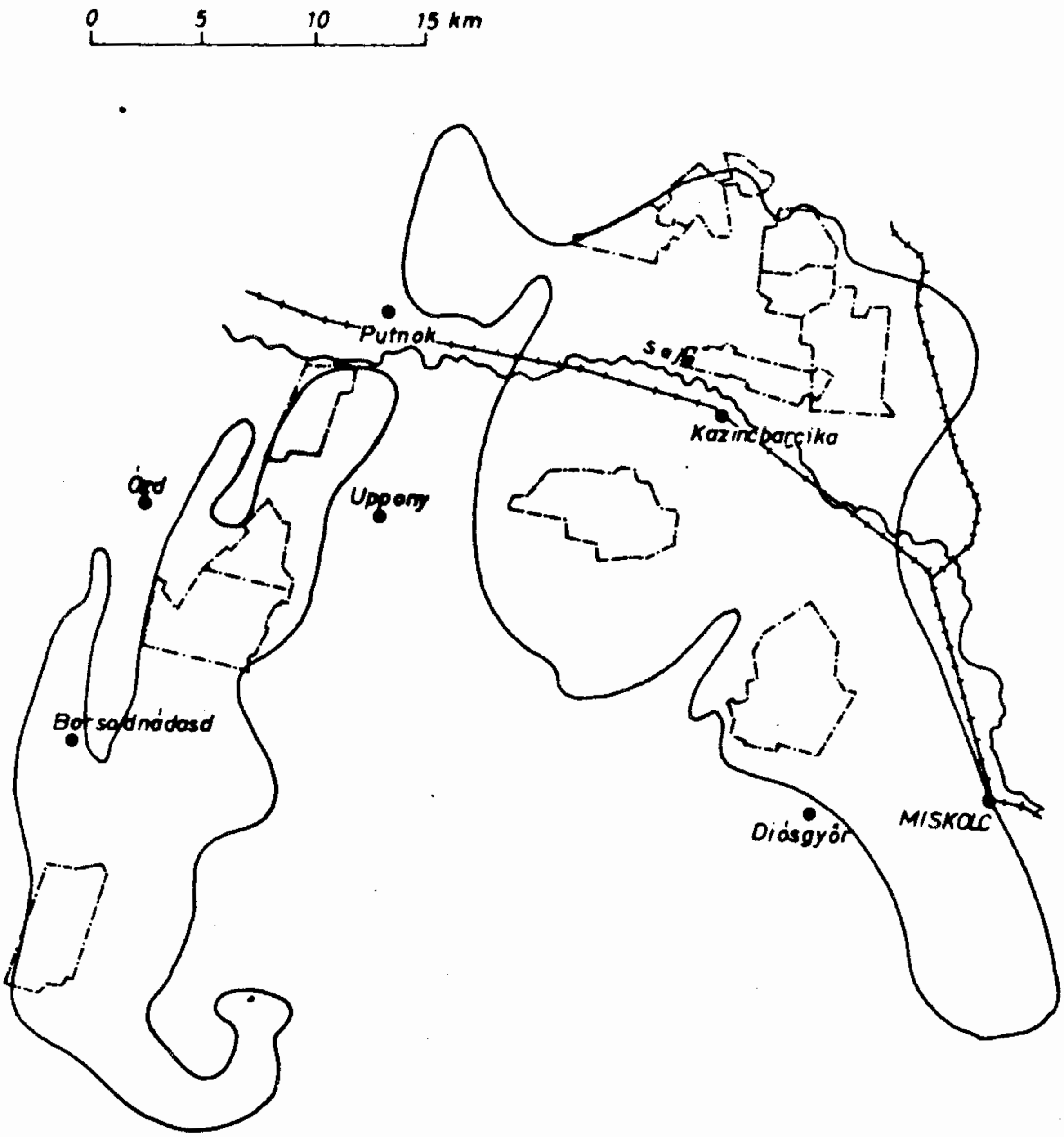
Places of the filtering wells in the developing roadway

1. Water observing place
2. Drainage wells
3. Inclined drift
4. Transport roadway with rubber band

Figure 8.

Technologic drawing of the drainage groundwater borehole with drived filter in Feketevölgy I. Colliery

1. Sand
2. Sandy gravel very watered
3. Sand, grey, fine grain
4. Sandx aleurit
5. Aleurit
6. Calcareous clay
7. Perforated, filtered section
8. Establisment of well head
9. Borehole wall
10. Synthetic pipe
11. Cemented locked boring head
12. Roof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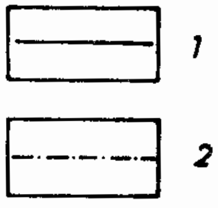
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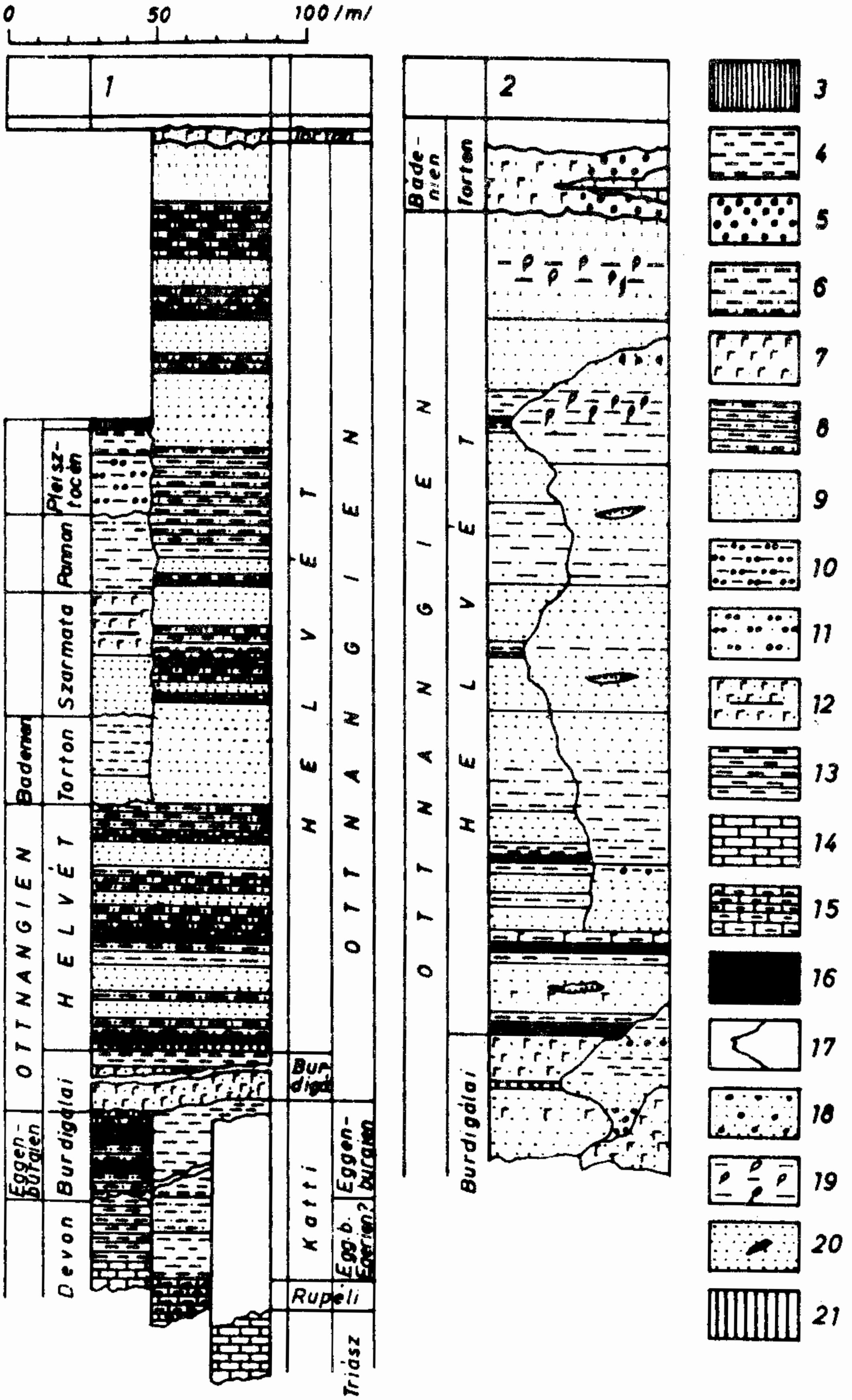
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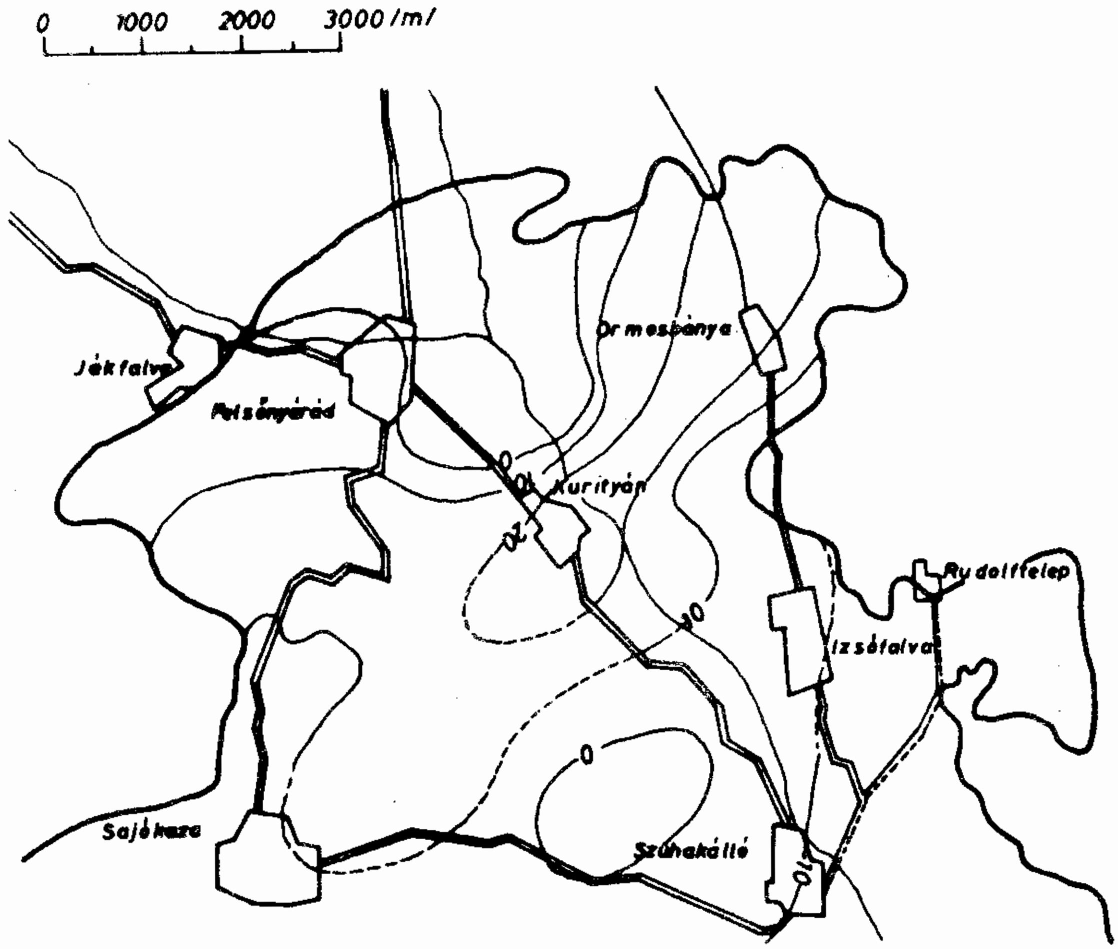
2. ábra Fig. 2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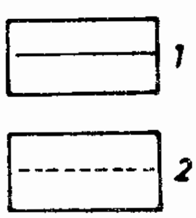
3. ábra Fig.3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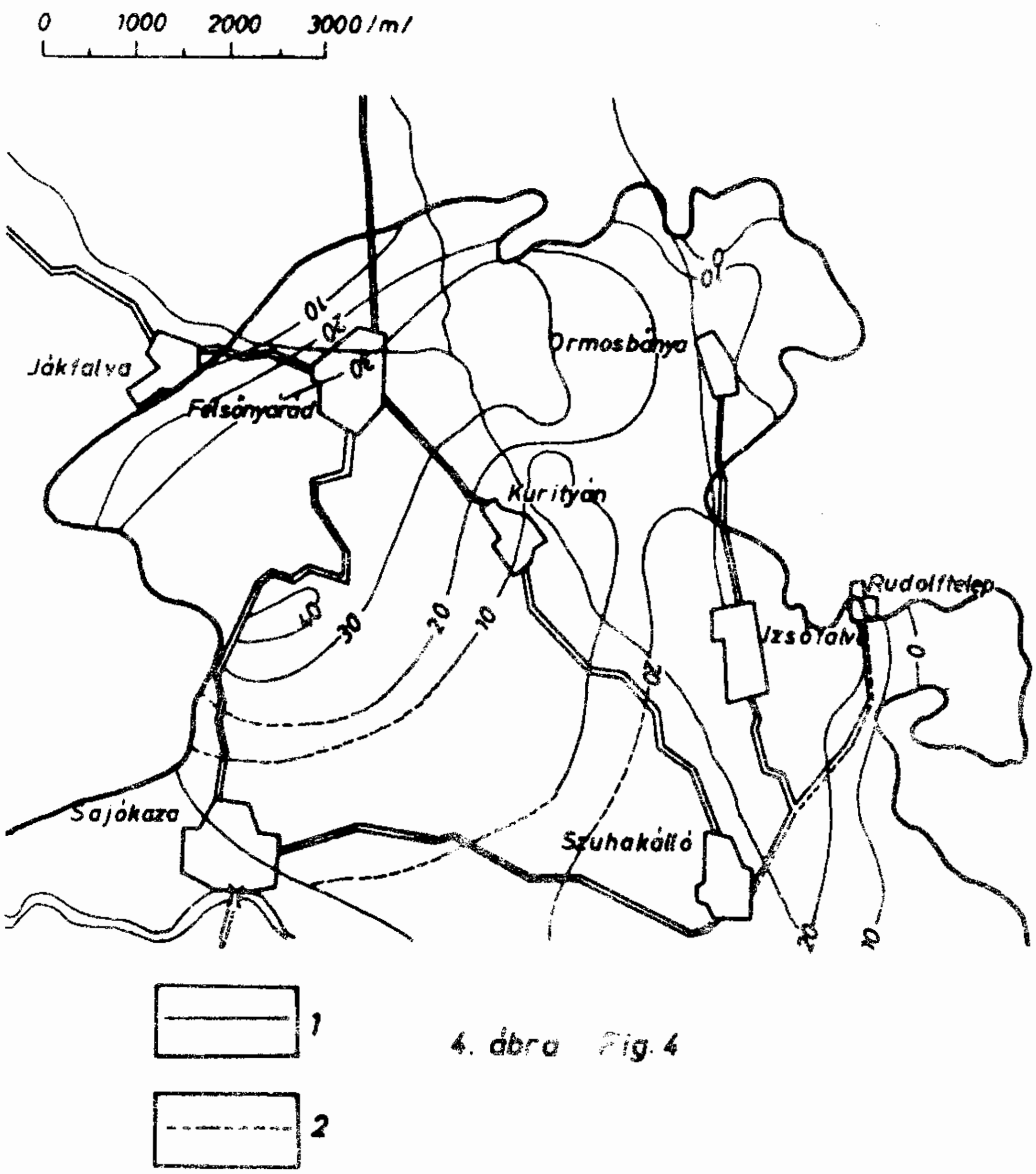
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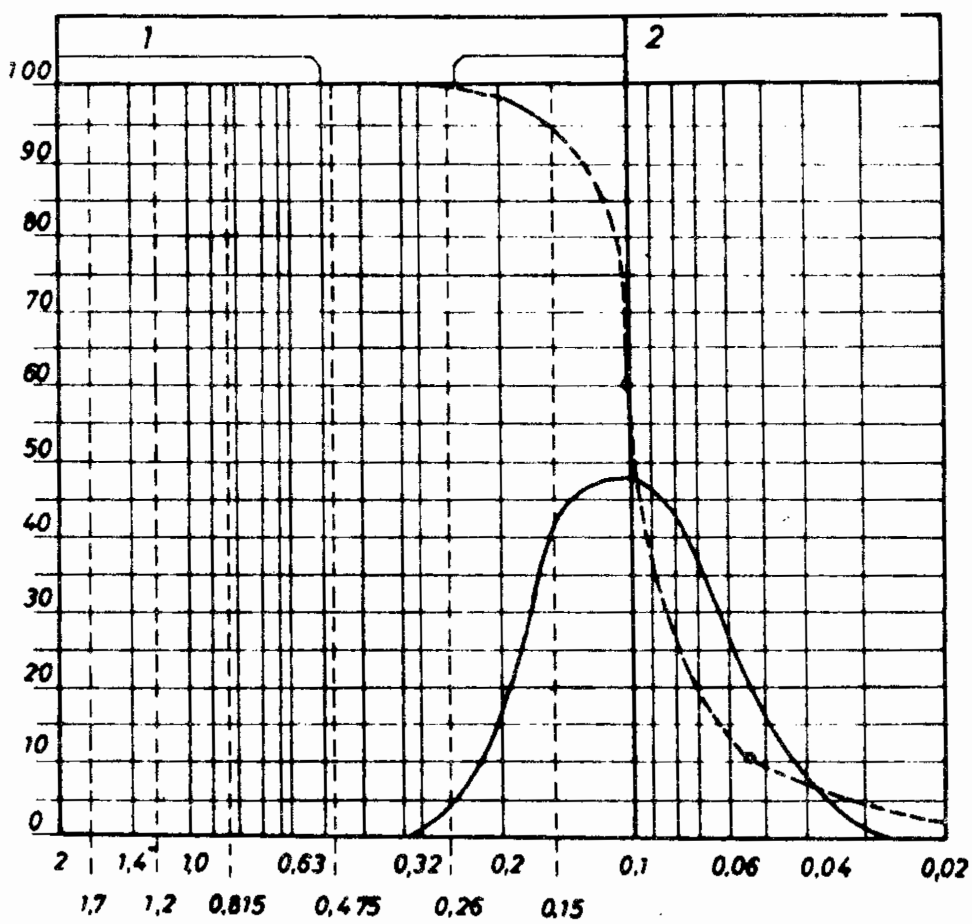
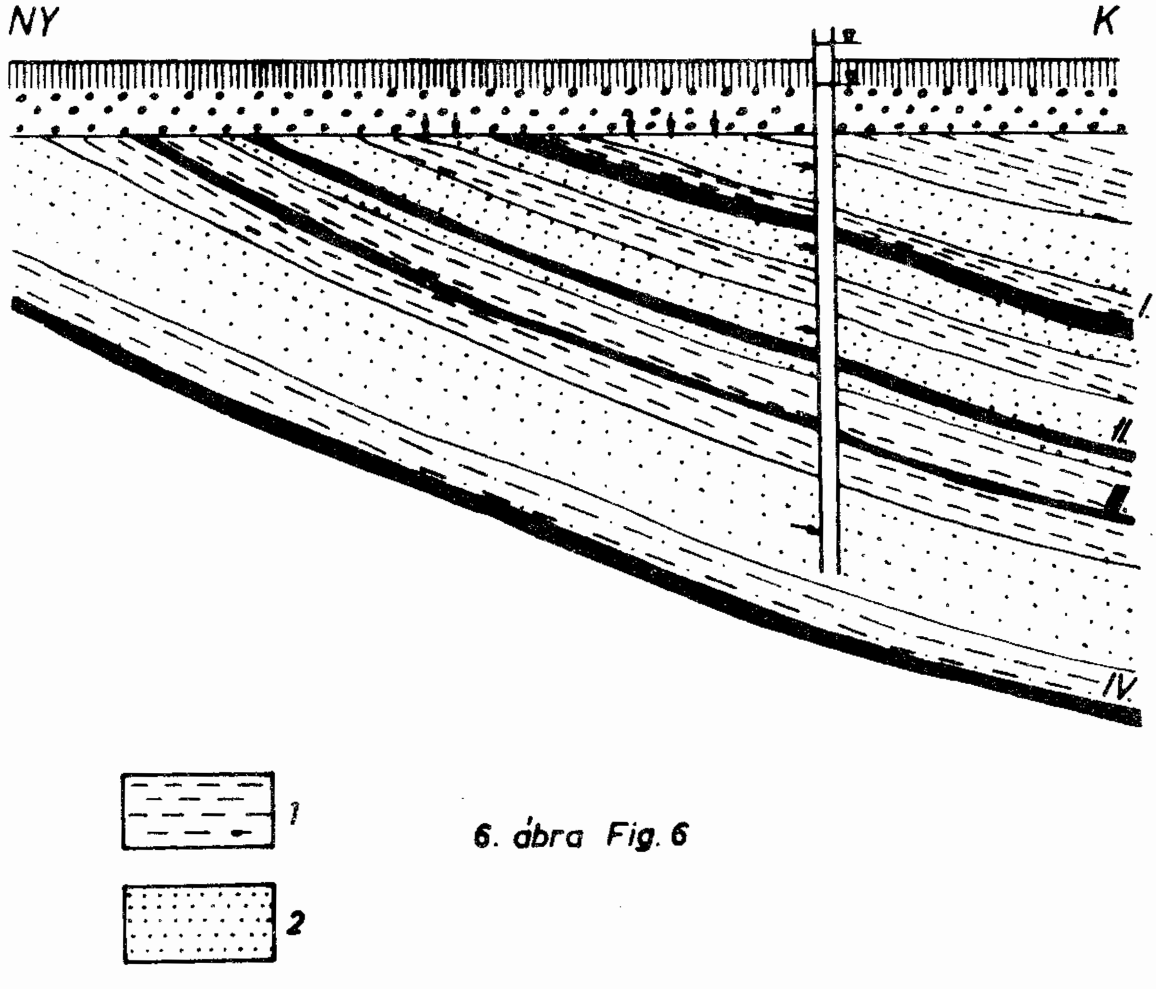


5. ábra Fig. 5

$D_m = 0,12$
$u = 0,1/0,055 = 1,82$



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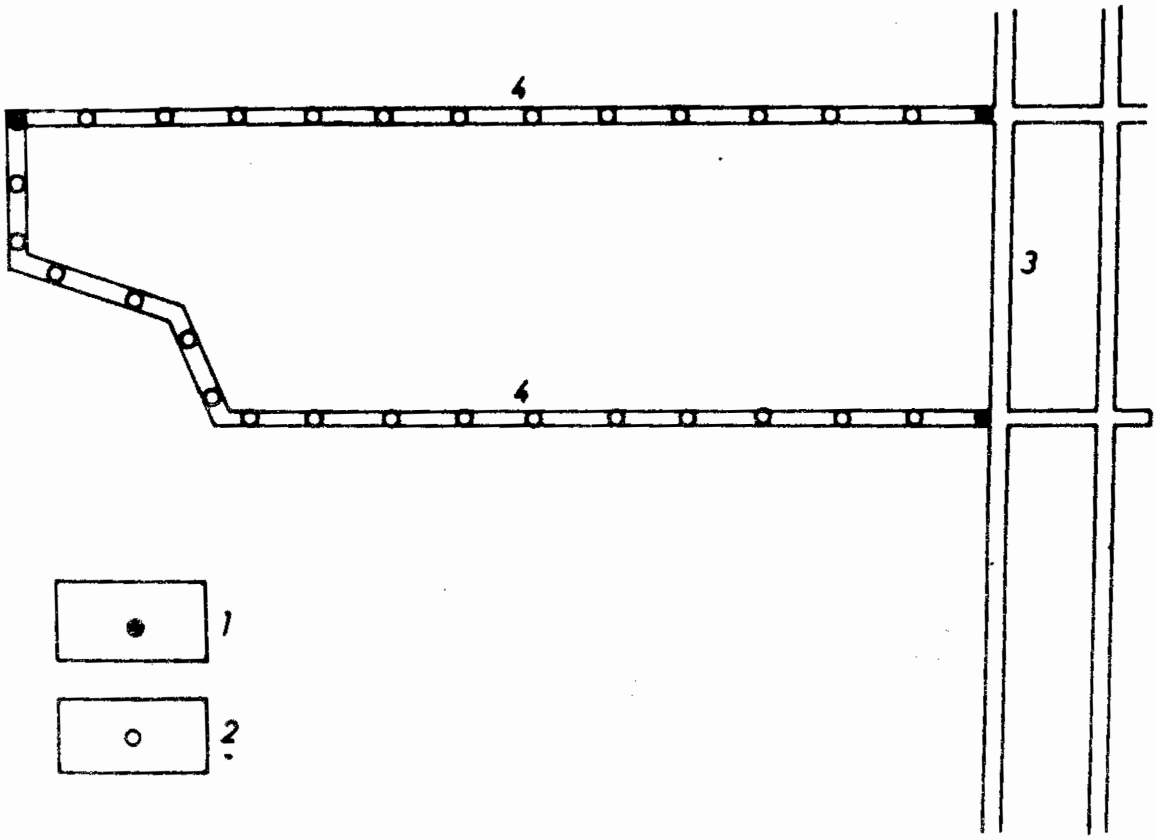

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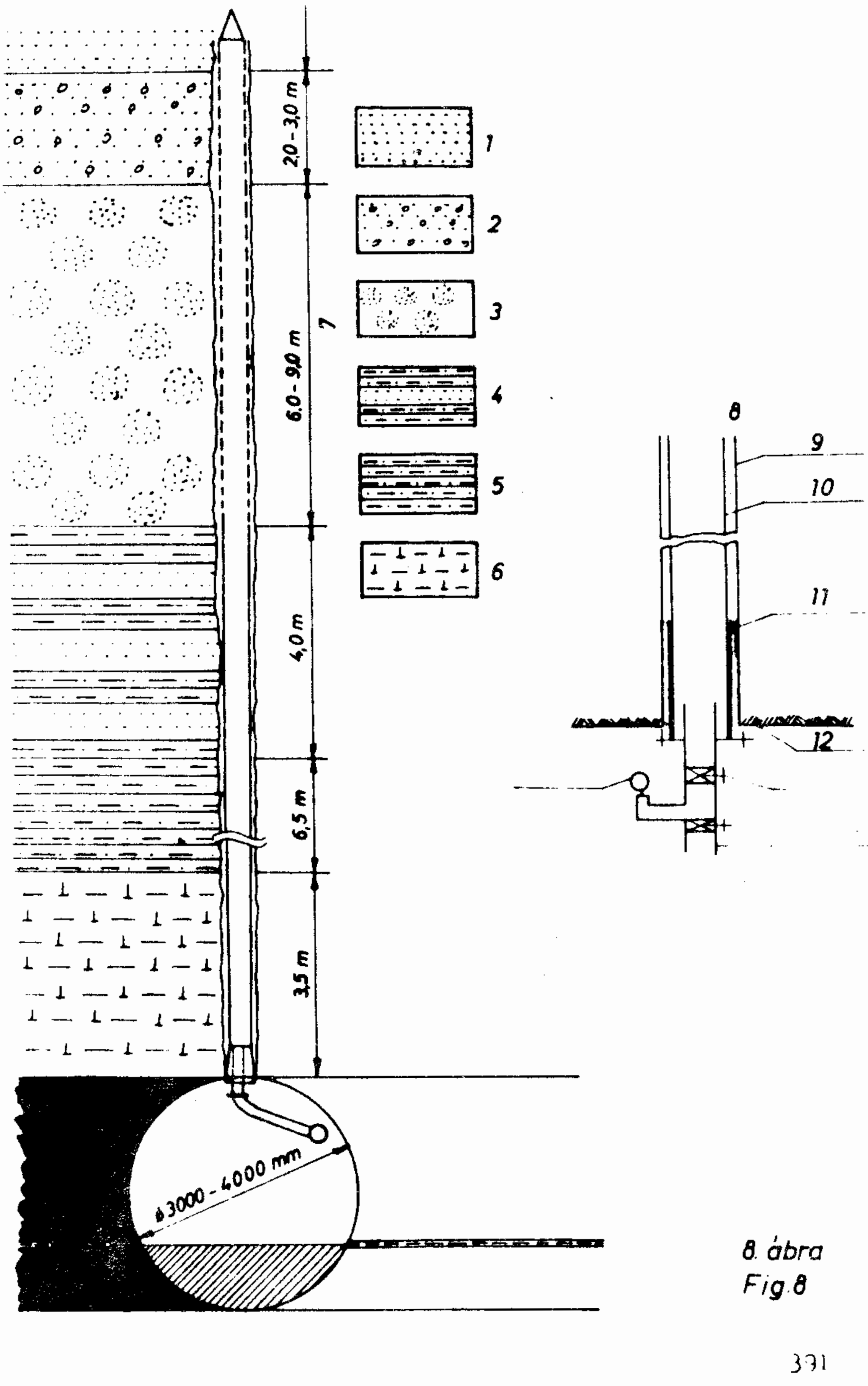

8. ábra
Fig.8