THE RELATIONSHIP AND COMPARATIVE ANALYSIS OF MINE WATER PREVENTION SYSTEMS AND PRODUCTION

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Tatabánya Coal Mines
2803 Tatabánya Pf.: 323.

SUMMARY

The study provides a detailed analysis of sources of mine water hazards, as well as their rate concerning the different aquifers.

It discusses the impact of the water hazard, the modes and economic aspects of the preventive measures in the early stages of mining activity. The developments in the mine water prevention are illustrated by the description of modifications required in mining methods, and the details of the method which was tailored to utilise the effects of the mine water prevention. The study presents a production method, which has been developed in the Tatabánya coalfield, and proved to be best alternative considering the water hazard.

The predicted water hazard was a main point of consideration in designing the production of the new large underground mines, thus two aspects has gained crucial importance:

- The determination of the optimal location and capacity, and the construction of the dewatering plants;
- The prevention of the modern, expensive equipments in the mechanised working places.

The special preventive measures applied in the development stage are discussed. The improvements and alterations in planning and construction due to the increasing knowledge is analysed in the context of effectiveness and economy of water prevention.

It is suggested that the methods and timing of the development of the main haulages should be carefully determined, parallel with the water prevention facilities.

It is shown, that a good accordance can be achieved between production and water prevention even in variable geological conditions. Production methods and mining systems are proposed, which can be applied in accordance with water prevention.

The role of the water hazard as a potential source of danger varies from place to place, as well as according the type of raw material. In the case of a producing mine the rate of water hazard is controlled by the distance from the aquifers in the adjacent rock masses, the properties and thicknesses of the strata separating the deposit and the aquifers, as well as the rate of tectonic disturbance. It is also of great importance whether the aquifer represents a closed system, or what is the rate of the water inflow if it does exist. The communication between different aquifers may make the problem more complex. Similar problems have to be encountered prior to production, in the development stage, and the water of the aquifers should be treated as a potential source of hazard during the construction.

Near to exhaustion after 85 years of production, in the Tatabánya Coalfield the conclusions of the water hazards and the preventive measures should rather be analysed from historical aspects /pretending no further surprise of this kind waits for us/. During this period, all types of water hazards have been occured, from rocks of different geological ages.

The waters contained in the hanging-wall strata of the coal seams did not represent serious impact, though a few cases are worth noting.

The water contained in Oligocene sands have caused serious problems in the development stage. Temporary difficulties were arised in the No. 12. shaft when the Dyscocyclina--limestone, far above the coalseams, has been opened along border faults as workings were getting closer to these structures. When this limestone has been drilled through by a hole, which has hit a drift, a large inrush was experienced in the No. 12/a colliery, and only the collapse of the hole has saved the level from a disastrous flood.

The water hazards caused by the presence of the Triassic basement aquifer was nevertheless the main factor to be encountered in the Tatabánya Coalfield. This factor has governed the development of preventive methods and the more data and knowledge have been gradually accumulated, the better was the understanding of the relationship of water hazards and production, parallel with the continuously increasing level of mechanisation and technology.

The Triassic basement consists of Dachstein Limestone and dolomites, which exhibit different character. The rate of inrushes coming from the more porous dolomite were lower, and their areal distribution were denser than those from the Dachstein Limestone. This rock type is more compact, but it also contains larger dissolved caverns, and caves. Less, though larger inrushes have been encountered from these rocks. 232 cases have been encountered, 107 from Dachstein Limestone, 125 from dolomite. The average rate was 2,5 m^3/min from the limestone, 1,2 m^3/min from dolomites /Fig. 1./. The largest inrush from Dachstein Limestone produced 60 m^3/min, which has forced the No. 15/b. shaft to be abandoned.

In the older mines the main factor in the preventive actions against water hazard was the determination of the capacity of dewatering stations. The main pump stations were always built on the haulage levels beneath the shafts, immediately after the shaft had been sunk down. Development workings were continued by drifting ramps and inclines outside the narrow shaft pillars, in order to achieve the production stage as soon as possible. Thus each mining block had needed an overlifting pump station which has transferred the accumulated mine water to the main dewatering station. If larger water inrush had occured, the whole block has had to be abandoned, the capacity of the main pump station had to be increased or new openings have to be developed. There are many contradicting opinions about the layout of these mines, i.e. why had the shafts and main pump stations not been located in the deepest point of the planned mineable area. The concept can be explained with technical and economic reasons. Priority was given to the early commencement of production in order to gain quick return of the investments. The provision of additional capacities to the pump stations has been treated as secondary problems, which can be solved in later stages of production. Even the risk of temporary or final abandonment of mining blocks was accepted. It is obvious, that in this period of the passive prevention neither the knowledge and evaluation nor the pumps were comparable to present standards.

In the period of passive of passive - preventive drainage control the sole preventive measures was the determination of sire and location of safety pillars at larger zones, which have been delineated.

If no protective layer was present, the number of roadways and working places was limited and the need of careful and organised actions was emphasized. Several inrushes have been prevented in this way. The route of draining of the inflooding water had to be selected first, starting from the catchment of water at the place of inrush, following by its direction into pipes, which were connected to the pumps. The dirt and rubbish in the drifts and working places have sometimes caused serious problems, since they have deposited at the inlet port of the pumps, decreasing their efficiency to such an extent, that its water lifting capacity was no more adequate.

The consequent plugging of the inflown waters /with cement-water or cement-water-sand mixtures/ was also applied in the Tatabánya Coalfield. However, its application was successful only if the water has achieved equilibrium conditions, and the barrier was constructed to hold the water pressure from the flooded area. Such operations made the reopening of a colliery /Sikvölgy/ possible.

In the 60's active prevention methods were introduced in the No. 14 and 15/c shafts. In both collieries considerable reserves were known. The seams were deposited immediately on the basement, or on a thin protective layer. Separate dewatering shafts were constructed, drifts were developed and holes were drilled from here to draw the water from the basement rocks down, with the aim to lower the water level on the area. The basement was dolomite in the No. 14. shaft, and Dachstein Limestone in the No. 15. shaft. In the 14/a shaft a drift was developed underneath the coal seam and 12 holes were drilled with 200 mm diameter. The discharge from the holes was 95 m^3/min, while the total water discharge from the drift and the drill holes amounted 110 m^3/min.

From the dewatering shaft of the No. 15/c colliery 4 holes were drilled to drain a cavern-system along a tectonic zone. These holes have yielded max. 40 m^3/min. water. The difference between the characters of the two aquifers is shown in Fig. 3. The depression cone is concentric in the dolomite, and elliptical in the limestone, with longer axis parallel with the fault zone. The difference has also been reflected in the efficiency of the dewatering operations. To discuss this problem in details is beyond the scope of the present study. However, some technical details and practical experiences of the draining operations through drill-holes in the No. 14/a watershaft is worth noticing. Gate valves have been installed on the stand pipes, which had been cemented into the holes. These valves can be remotely controlled from behind the safety barrier. This arrangement is advantageous from safety reasons, and reduces the pollution of the water too.

As mentioned, the theoretical volume of the total discharge was 110 m^3/min - 15 m^3/min from the drift and 95 m^3/min was the sum of yields from each drill holes - this equalled approximately 75-85 m^3/min if the "contemporaneity" coefficient was considered. The working capacity of the dewatering plant was 60 m^3/min. /Fig. 4./ This limitation had to be kept in mind in planning the production in the seam on two wings from its centerline. The concept has been proved to be correct in the final evaluation. The sequence and intensity of the discharges have been controlled. The drill-holes beneath the producing panel were set up to maximum discharge, while those under the developments were closed, and the total available capacity of the pumps was always utilised. With such control the water which has flown into the working places could even have been drawn down.

As is shown in Fig. 4. obtained depression did not provide sufficient prevention for the lowest parts of the seam, which has been extracted by downward slicing, in five slices. For this reason an entry was drifted into the lowest, not mineable section of the seam from the producing mine, backed by the prevention provided by the existing dewatering plant. From this entry the water was drained throngh holes drilled underneath the seam to be produced. This planned, preventive measure was a consequence of an accident, when a downward longwall had been almost flooded by an 5 m^3/min inrush, which has been eliminated by draining with holes drilled upwards from a deeper point.The practice and experience gained at the No. 14. shaft was utilised in the further developments of complex water prevention methods.

In the No. 15/c shaft the drawdown of the karst water level was inadequate to increase the specific dewatering of the producing mine to a greater extent. Since this mine was highly mechanised, very productive and economic, a new passive dewatering method was developed.This type of prevention has become necessary to prevent or to prepare for handling water inrushes in order to protect the costly equipments in the mechanised longwalls. The mode of developments were called as three-drift system /Fig. 5./. Essentially, a water-entry is driven beside lower ribside entry of an upward advancing longwall, leaving a narrow rib between the two drifts. This water-entry is connected to the ribside entry by crosscuts. The water-entry itself is connected to main dewatering drift. Pipes are installed in the goafside drift to drain any water inrushed before the crosscuts are completed. The water-entry becomes the ribside dirft in the adjacent panel. This method was used as a mining system in the Csordakut colliery. Where certain blocks were situated under the water level. At Csordakut the prevention was enhanced by drilling 200 mm dia. holes in lengths equal to the width of the longwall into the travertine strata lying beneath the coal seam under a 3-6 m thick protective layer. In this way the water has been deliberately released from this aquifer.

In planning the production, once the direction of the advance of longwalls had been decided, the production sequence should be determined /Fig. 5./. The water can be discharged along a prepared route, or alternatively it can be led into the goaf, if bottom-point discharge can be predicted. In the latter case upward advancing stopes can be established, and the water from the longwalls accumulates in the lower goafside drift, where it flows into the goaf of a deeper longwall stope. If the production is carried out in two or more slices, this method is not safe any more. Experiences have shown that the water can not flow freely in the goaf on a permanent basis. Thus it is necessary to drive a "third" drift to secure the safe discharge of water. As production sequence downward direction was chosen. This alternative offers the following advantages:

1./ there is no need to maintain permanent pillars for the roadways, intake and return airways, water entries, these pillard can also be stoped out;

2./ the haulage drifts on the lower /-deeper/ sides of the longwall can be better preserved if driven in a larger distance from goaf of the preceding longwall.

3./ the ribs, which separate the adjacent longwalls are smaller, and can be stoped utilising the conveyors of the longwalls.

In the Tatabánya Coalfield considerable experience rised from the long tradition of water problems. These informations have been already available in the planning stage of the modern mining, and most of them could have been used. It is widely known that the arguments preceding the development of new mines were mainly focussed on the complex problem of water hazard. Expensive hydrological tests have been carried out. Their evaluation has provided a reliable basis for the prediction of the hydrological properties, flow rates, dischargeability of the aquifers, and the potential degree of water hazard.

Two main aspects have governed the planning of production from the large modern mines:

- the capacity of the dewatering plants had to be carefully analysed, determined and installed;
- to avoid situations, when incidental water inrush might flood the modern, mechanised, expensive working places.

In the first task the determination of a suitable safety factor is necessary, which incorporates the predicted maximum volume of accidental water inflow or inrush. Facilities have to be provided to sediment the solid material carried by the water.

The second question is to be analysed when the initial developments are located, or the place of the main pumping station is to be determined. Based on previous experiences, our main concept was to allow the water to flow gravitatively to the main pump station, in opposite direction with the advance of the stopes. Provisions, like traps for solid matter, pipes should also be installed, when necessary, using improved methods.

Using this principle, the main dewatering station should be located in the deepest point of the mine, or the mineable area. In mines, which produce more types of raw materials - like in the Nagyegyháza colliery - the deepest point refers to the lowest deposit - in this case the bauxite.

What are the consequences of this governing principle to the relationship of the mining methods and water prevention in the construction, development and production stages of a new mine?

During the construction, the shafts and inclines have to transsect the aquiferous Oligocene sands and the Eocene Alveolina - limestone in the overlying strata above the coal--seam. Their communication with the travertine limestones within, and the dolomites below the coal seams should be tested. In this stage the main factors are the safety, cost and time of construction. At Tatabánya the time was of primary importance, owing to the several years delay. Following the evaluation of data gained from the drill-holes in the axes of the planned shafts, /dewatering shaft and intake shaft/ the contractor /Bányászati Aknamélyitő Vállalat/ has taken the risk to sink the shaft through the younger sands, sandstones without freezing.

0,6 m^3/min and 0,2 m^3/min water was lifted in the dewatering shaft and the intake shaft respectively. It should be mentioned, that six 216 mm dia. drill-holes were drilled from the surface to 54 m depth around the dewatering shaft, and water-wells were constructed. 1 m^3/min water was pumped from these wells, and this operation has provided adequate depression to ensure the conditions for shaft sinking. The Alveolina-limestone has also been tested by drill-holes. Though the preliminary injection of these strata had been planned, this was proved to be unnecessary. The hit of the lower aquifers were to be avoided. Water has flown into the dewatering shaft from a predraining hole, which has been consequently injected. This injection has allowed to reach the bottom succesfully in a safe way, leaving a suitable specific protective layer.

It is now proved that the traditional method of shaft sinking in this case was not only time - saving but also less expensive than the freezing method. This case is a good example for how can positive results achieved by accepting the risk coming from the unsolved questions of the evalustion of preliminary tests.

At Nagyegyháza and Mány the paths of the main inclines have been tested by drill holes. At Nagyegyháza, when the direction of haulage has been decided, the inclines were driven on the western side. They transsected only the Alveoline--limestone. Injection was initially planned in this section. Underground tests have revealed that this was not necessary

/Fig. 6./. In the design of the twin inclines at Mány the Oligocene kaolinite-containing marly sand has required great attention. A special pre-draining method was planned on this section. The results, obtained from the test holes drilled from the heading have proved, that there was no need to apply this preventive measure. Dolomite was situated underneath the inclines. Its proximity has necessitated special protection. Insulation is being carried out with a method developed by the Central Mining Research Institute using a sealant material made under Soviet licence, through a drill hole, from the surface.

Large variation was observed between the predicted and the actual properties of the aquifers during the construction. These variations may highly effect the technology, and consequently the time and expenses of the workings. We do not want to criticise the predictions, since these were very comprehensive, and also suggested the higher risk alternative. It has to be emphasized, however, that total safety is not the best alternative, if it requires methods, which are frequently much more expensive than the others. This opinion refers rather the earlier disputes over this matter, and not the present case.

The problems of the design of the developments of a water hazardous mine differ according arrangement of shafts, inclines and dewatering stations. When the developments start from a shaft, which has been sunk down to the deepest point of the coal-seam after the main dewatering station has been completed, the development headings are advancing in one direction upwards, and the main dewatering station provides suitable protection. If inclines are developed, or the headings are advancing in more directions, the main dewatering station is installed only when developments have reached the deepest point of the mine. In the first case the main dewatering station may alone be suitable to provide adequate protection. In the second case, however the time needed for the development is shorter. At Nagyegyháza a dewatering plant was installed to protect the development headings. Its construction has been carried out after the intake and conveyor-inclines and the adjacent main openings have been completed under large specific protection. There were both time considerations and economic aspects in chosing this arrangement. The capacity was given in 35 m^3/min, as determined by the prognostised value of water inflow during the developments. In the first stage the deepest point of the mineable area was given in the -130 m b.s.l. level, while the haulage level was located at the +30 m b.s.l. level. This 160 m vertical distance was traversed by a twin raise in 900 m length. The development of these two headings was thought to be a difficult and interesting task, since the protection of these drifts were not adequate, as calculated to the travertine aquifer between the two coal seams. The raises were driven by mechanised technology. The protection was provided by two 200 mm dia. pressure lines, which have always been connected to the mobile pumps at the headings. No water has been drawn. The excavations of the dewatering station at the +130 m level, in the hanging wall are practically completed. The travertine which has been tested by several drill-holes, was proved to be more favourable than predicted along the path of the main raises.

Similar principles have to be followed in the planning of the mining blocks. The main aspect i.e. the gravitative flow of the incidentally or deliberately released water, requires updip advancing drifting, even in the development headings. This consideration has to be kept in ming in the arrangement of the water entry on the lower boundary of a longwall stope, even if it has to cross aquiferous layers on its path. In this case, however, it might be practical to apply preliminary rock sealing on the aquifer in the section of the drift and the adjacent zones. Its layout should be planned in such a way that the footwall rocks should be connected to the lower water entry of the longwall stope even if the tectonic conditions are not properly known.

It is reasonable to drive the development drifts from the water entry. The treatment of the waters released by the upward advancing drifts is less difficult and expensive than those from downdip drifts, where the inrushed water might adversely effect the advance even when the capacity of the pumps at the headings have been properly chosen.

The complex method of water prevention and its relationship with mining in the Nagyegyháza mine where more seams and type of raw materials are to be mined, is shown on Fig. 1.

The dewatering plant, with 75 m^3/min capacity, is to be installed on the -130 level. 13 million tons of coal and 5 million tons of bauxite is found in this occurence. This plant provides the protection for the extraction of a part of the coal reserves as well as for the bauxite production planned in the first stage. A second dewatering plant is planned at the V-1 shaft, which would also be connected to the drainage network. From that time the present plant will only pump drinking water from the dolomite beneath the bauxite.

The upper coal seam will be mined with passive water - prevention. The Alveolina-limestone, which lies 40 m above the seam is tapped by drillholes already in the development stage. Only negligible amount of water was drawn from the limestone above the first developed mining block, since the limestone was more compact, less fractured in this place. Since the thickness of the protective layer is 40 m, and the strength of the overlying strata is increasing with the distance from the coal seam, future experiences will give the answer for the behaviour of the limestone and the mode of discharge of the semnant water, which will be stored in it. The development of Weber-cavities might also be encountered.

Marls are found in the immediate footwall of the upper coal seam. Though these rocks are impervious concerning the water hazards from footwall strata, their thickness is insufficient to provide suitable specific protection against the waters from the underlying travertine limestone. The experience gained from underground developments snow, that its properties are more favourable than expected, in a regional scale. This opinion has resulted from the exposed sections of these strata in the initial development workings, as well as from the success of several kilometers driveage which has been carried out with inadequate specific protection, but no water has been got. In the upper coal seam the three-drift system is planned with a modified arrangement. The third drift will be located away from the longwall-heading near the goaf, in stress-released area. A drainage pipe is installed and left in the lower ribside drift of the stope in the goaf. When it will be reached, this pipe will be reopened in regular spacings and connected to the water entry. Other two alternatives have also been evaluated: the application of the drainage-pipeline left in the goaf as the only prevention, or the drive of the third drift adjacent to the goaf. It is not clear, however, whether the pipes and jounts can resist to the load produced by the goaf, or the rock debris carried by the water does not blind the pipes. In emergency it is possible to hole through quickly to the junction of long walls from a mearby drift. The goaf-side drift means increased fire hazard, even at proper ventillation,since the coal from the unmined upper slice unavoidably mix with the waste in the goaf because of the uneven bedding. In other collieries 3-5 m wide rib was successfully used to prevent generation of fire. At the Csordakut colliery, however, great difficulties had to be overcome to maintain the third drift, which was ahead of the longwall face.

The travertine limestone gives the immediate hanging-wall of the lower coal seam. A great number of data about its hidrological properties will have accumulated until its extraction begins. In the hydrological test holes the static head of the waters of this aquifer was similar to that of the dolomites in the footwall, owing to their communication along faults. It will be tapped by holes drilled from a multi-purpose drift developed at the base of the coal seam. Drill-holes will be necessary mainly along the tectonic zones.

One of the most difficult tasks is the floor-side protection of the multiple sliced production of the lower coal seam. The incidental water-inrush into producing faces should be avoided as possible. For this reason water entries will be developed with 200-250 m spacing parallel with the development drifts of the planned longwalls over them. From these drifts large diameter holes will be drilled parallel with the footwall line towards the planned longwall faces. Provisions have to be made to install perforated casing in these holes. The holes will either directly tap water of the aquifer, or induced water inflow might develop on the periphery of the holes by the effects of the approaching longwall face over the holes. Both processes can create adequate protection for the stopes. The three-drift system in the development works may also increase the safety.

The exploitation of the bauxite reserves will follow the extraction of the coal seams. For water prevention drifts will be developed in the footwall dolomite and the water will be tapped by drill-holes made from these drifts, to create a local drawdown. The reworked dolomite, which is situated in the hanging wall, will have limited water reserves with no additional supply.

This water will be drawn by drill-holes containing perforated casing. Sublevel-caving method is planned for the mining of the bauxite. The caving of the first stopes at the deepest level of the orebody will also increase the efficiency of the discharge of the hanging wall aquifers.

My aim was to give a summary of the water prevention methods and practices which will be introduced in the mining at Tatabánya during the future new period. These methods and practices are based on the knowledge and informations gathered from the exhausting Tatabánya Coalfield, and at the Csordakut colliery, which has similar hydrogeological properties to that of Nagyegyháza. The staff, which is responsible for the actual tasks of construction and mine development, is provided by a through and comprehensive evaluation as a result of cooperation of institutes, committees and individual experts. Despite of this, I believe that there is still much information and experience which have to be collected and evaluated in the future, ideas, opinions and practices will be improved, modified or even altered along with the scientific, technical and technological developments.

Mellékletek jegyzéke

List of Supplements

1./ A Tatabányai medence fajlagos védőréteg térképe
SPECIFIC PROTECTIVE LAYER MAP IN TATABÁNYA BASIN

2./ Szelvény a XIV/a vizakna szivattyúkamráján keresztül /A - A' metszet /
SECTION THROUGH THE PUMP CHAMBER OF INLET WELL No. 14/a SECTION A - A'

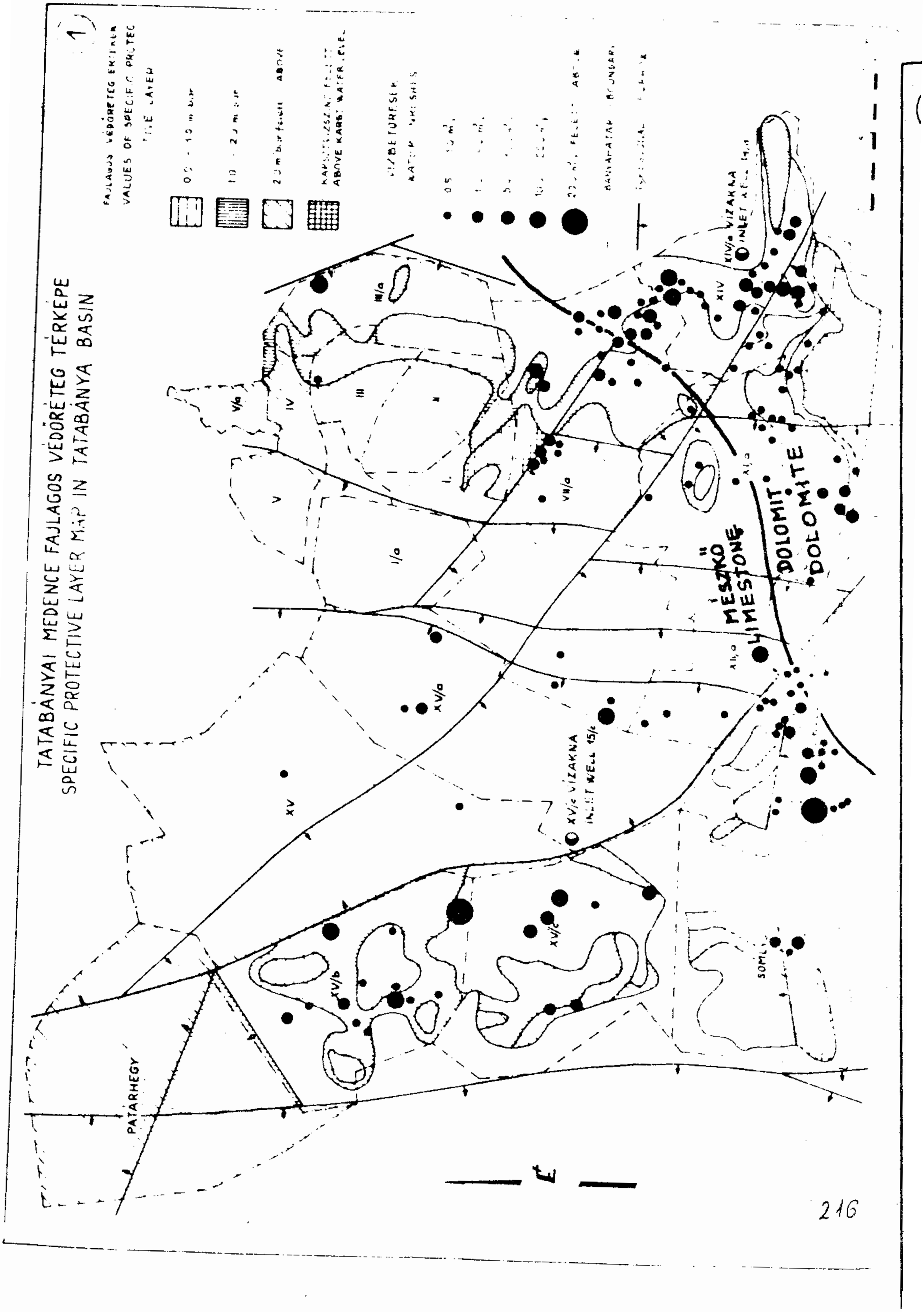
3./ Tatabányai Medence karsztvizszintvonalas térképe
KARST WATER LEVEL CONTOUR MAP OF IN TATABÁNYA BASIN

4./ Vizszintsüllyesztés a XIV-es aknán
WATER LEVEL DEPRESSZION IN SHAFT 14.

5./ Fejtések telepitési sorrendje
LOCATION ORDER OF FACES

6./ NAGYEGYHÁZI feltárási vázlat
NAGYEGYHÁZA OPENERING MAP

7./ Vizvédelmi rendszer és a bányamüvelés kapcsolata
CONNECTION BETWEEN WATER PROTECTION SYSTEM AND UNDERGROUND MINING

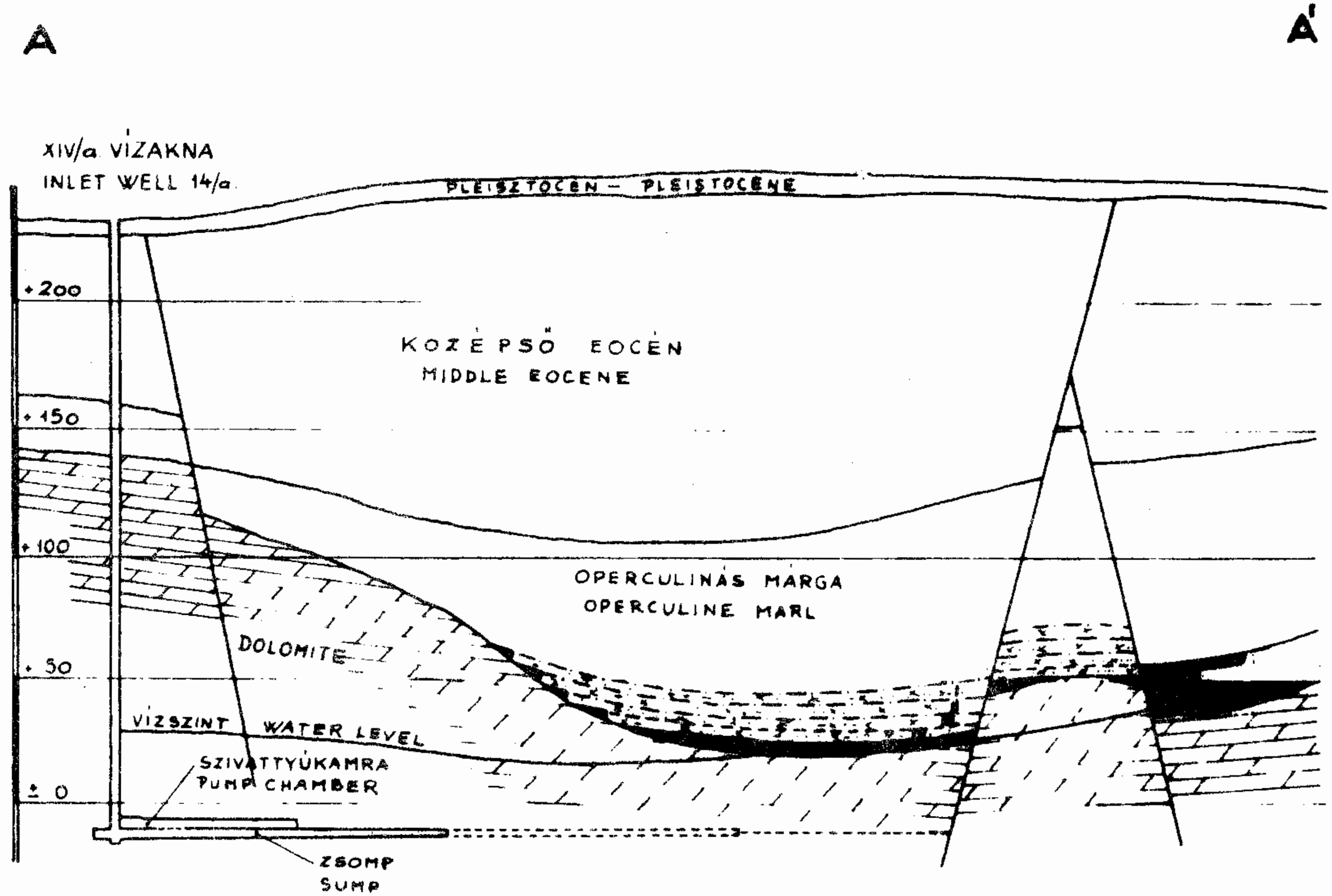

TATABÁNYAI MEDENCE FAJLAGOS VÉDŐRÉTEG TÉRKÉPE
SPECIFIC PROTECTIVE LAYER MAP IN TATABÁNYA BASIN
MÉSZKŐ
LIMESTONE
DOLOMIT
DOLOMITE
XV/c VÍZAKNA
INLET WELL 15/c
XIV/a VÍZAKNA
INLET WELL 14/a
PATARHEGY
SOMLÓ
XV
XV/a
XV/b
XV/c
XIV
I/a
V
V/a
IV
III
VII/a

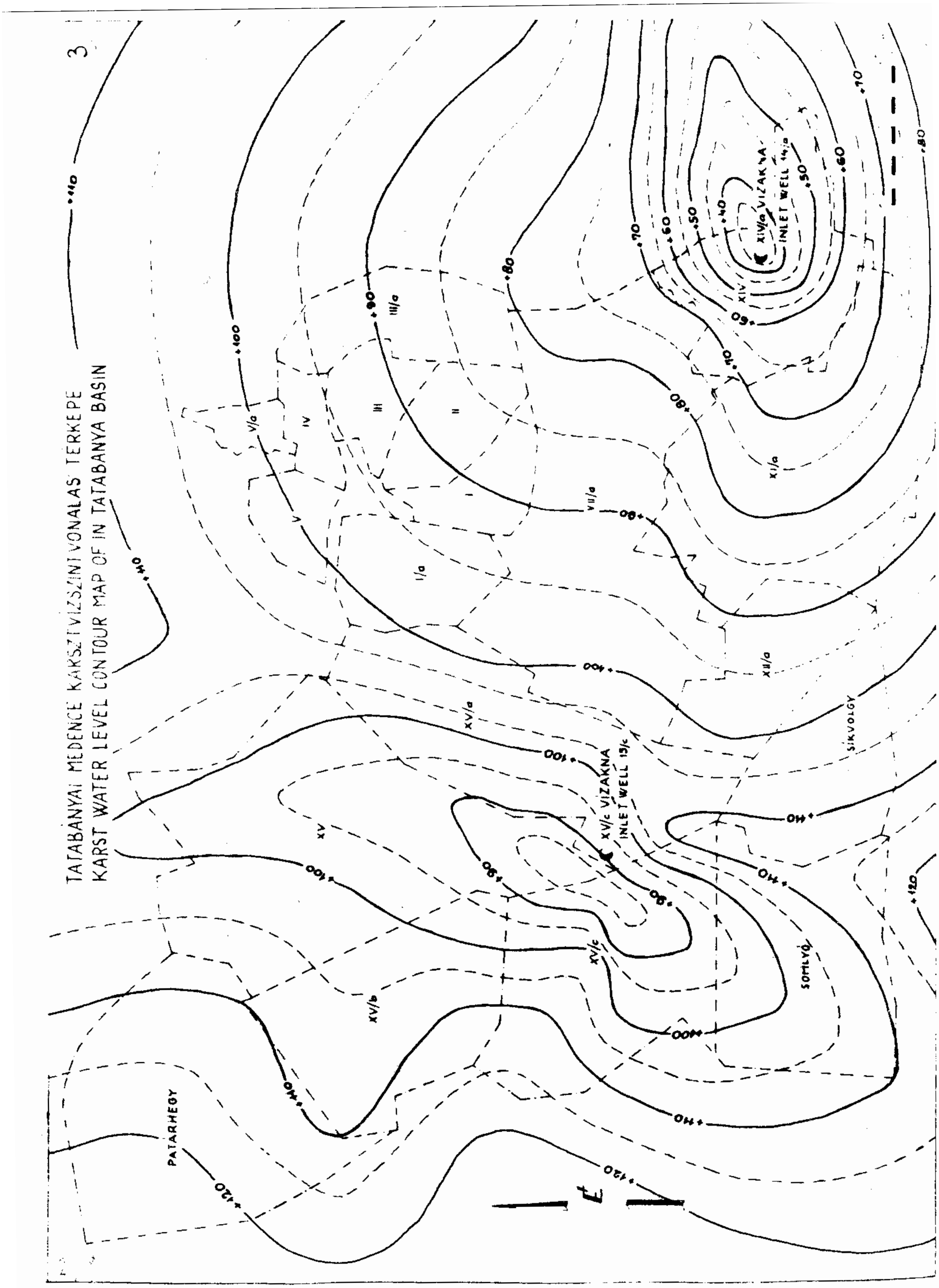
(2)

SZELVÉNY A XIV/a. VÍZAKNA SZIVATTYÚKAMRÁJÁN KERESZTÜL.
A–Á METSZET.

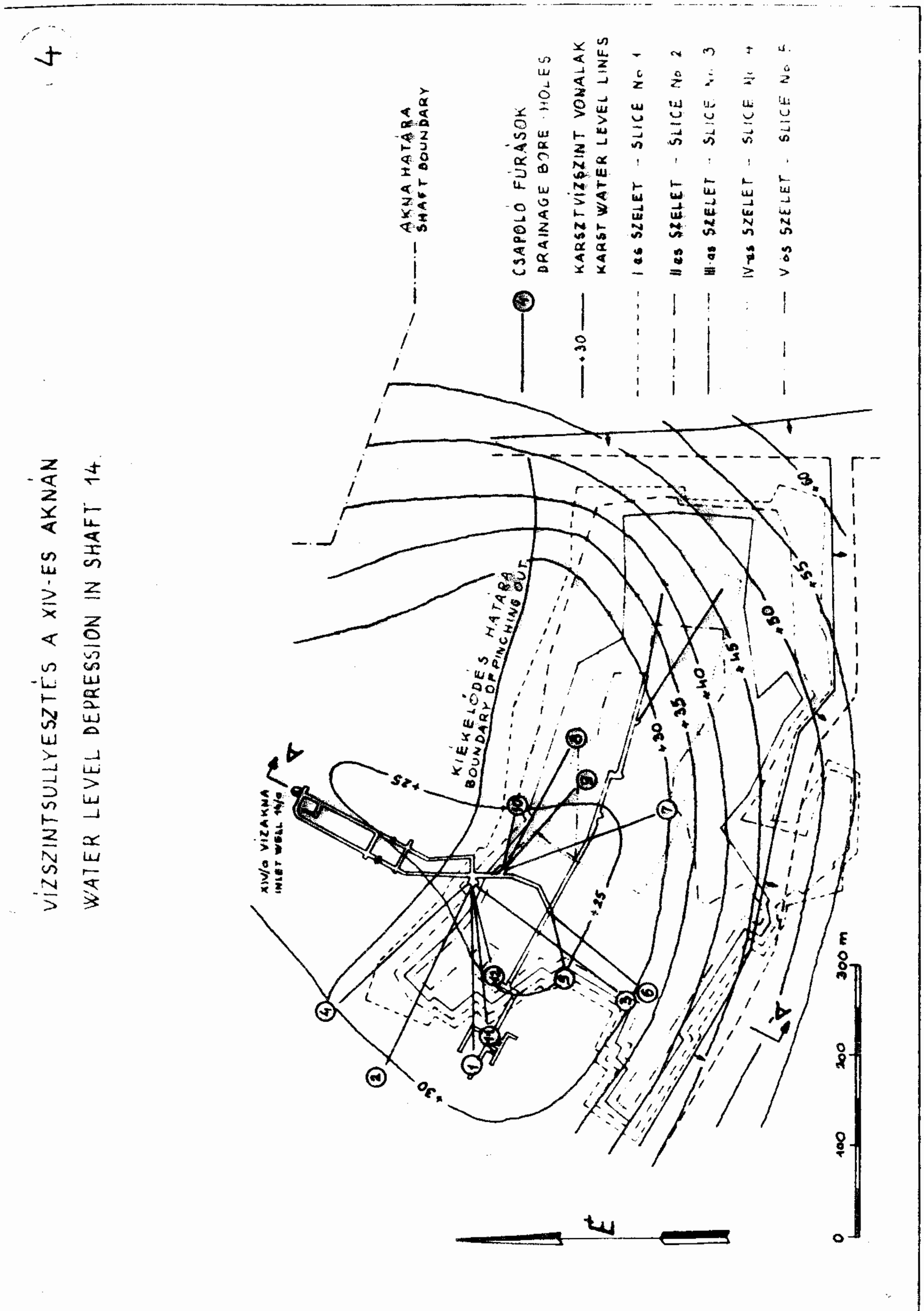
SECTION THROUGH THE PUMP CHAMBER OF INLET WELL No. 14/a

SECTION A–Á





TATABANYAI MEDENCE KARSZTVIZSZINTVONALAS TERKEPE
KARST WATER LEVEL CONTOUR MAP OF IN TATABANYA BASIN


4
VÍZSZINTSÜLLYESZTÉS A XIV-ES AKNÁN
WATER LEVEL DEPRESSION IN SHAFT 14.
AKNA HATÁRA
SHAFT BOUNDARY
CSAPOLÓ FÚRÁSOK
DRAINAGE BORE HOLES
KARSZTVÍZSZINT VONALAK
KARST WATER LEVEL LINES
+30
I-es SZELET - SLICE No 1
II-es SZELET - SLICE No 2
III-as SZELET - SLICE No 3
IV-es SZELET - SLICE No 4
V-ös SZELET - SLICE No 5
KIÉKELŐDÉS HATÁRA
BOUNDARY OF PINCHING OUT
XIV/a VÍZAKNA
INLET WELL 14/a
A
+25
+30
+35
+40
+45
+50
+55
+60
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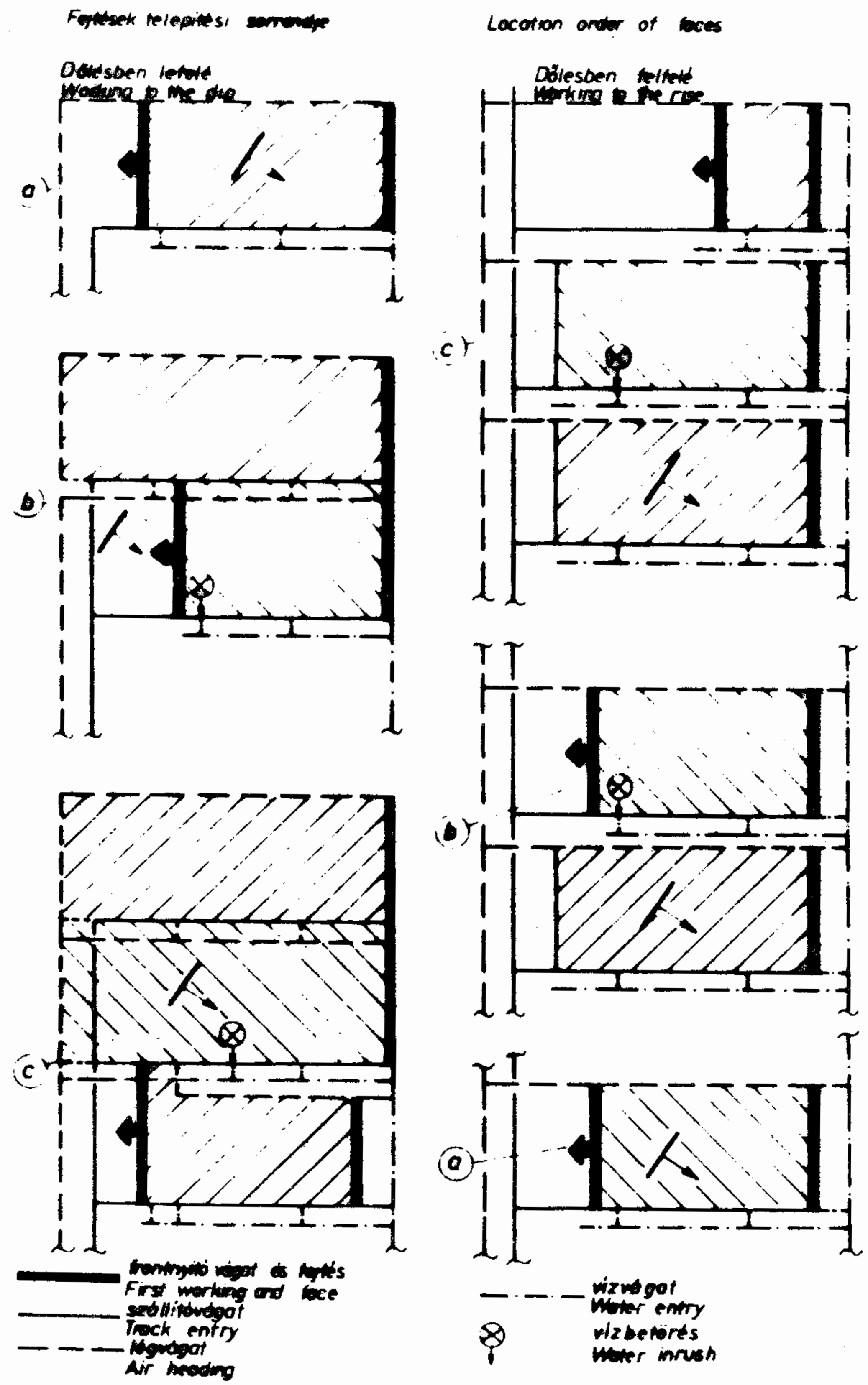
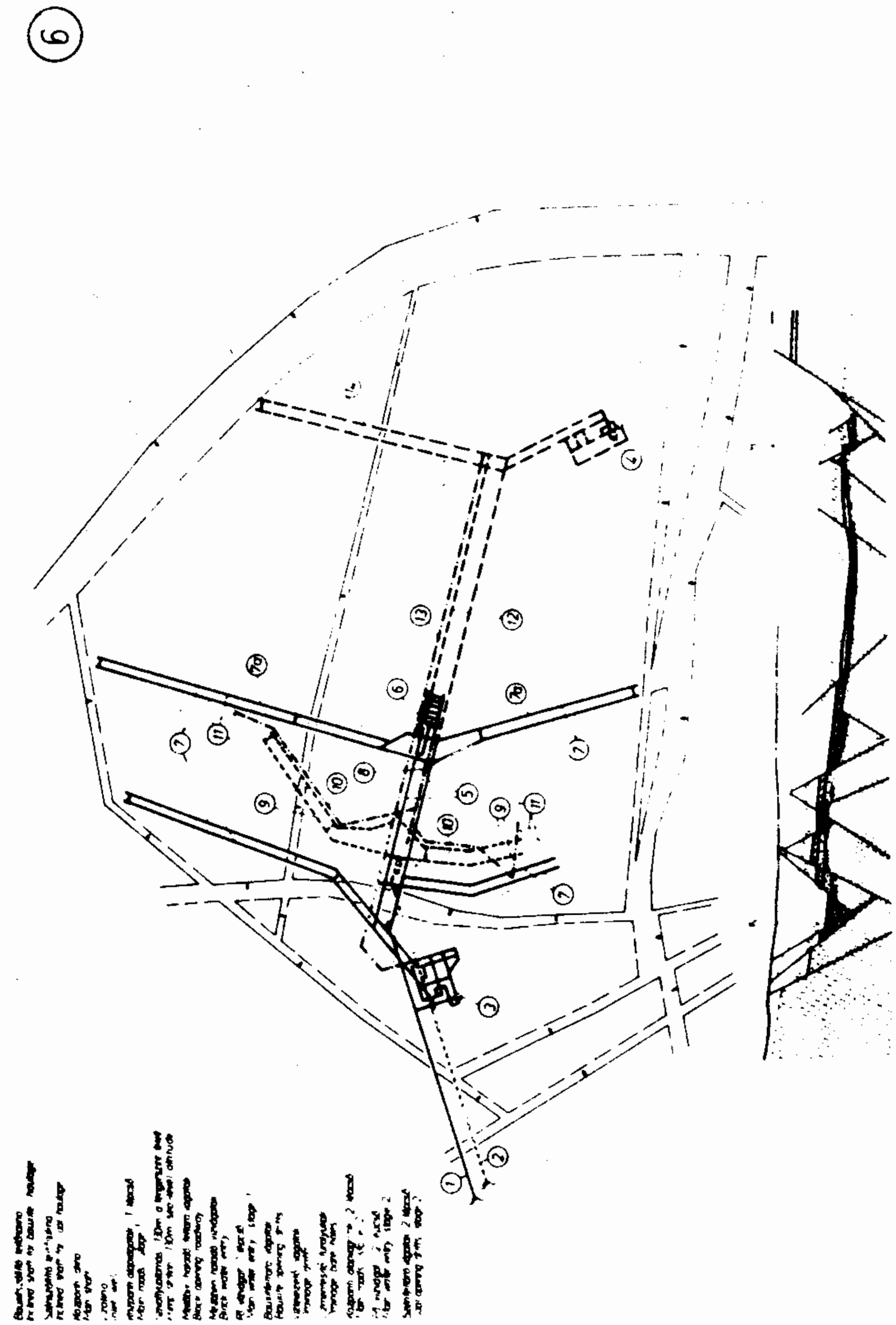
100
200
300 m

(5)


Fejtések telepítési sorrendje
Location order of faces
Dőlésben lefelé
Working to the dip
Dőlesben felfelé
Working to the rise
a
b
c
c
b
a
frontnyitó vágat és fejtés
First working and face
szállítóvágat
Track entry
légvágat
Air heading
vízvágat
Water entry
vízbetörés
Water inrush



VIZVÉDELMI RENDSZER ÉS A BÁNYAMÜVELÉS KAPCSOLATA

CONNECTION BETWEEN WATER PROTECTION SYSTEM AND UNDERGROUND MINING

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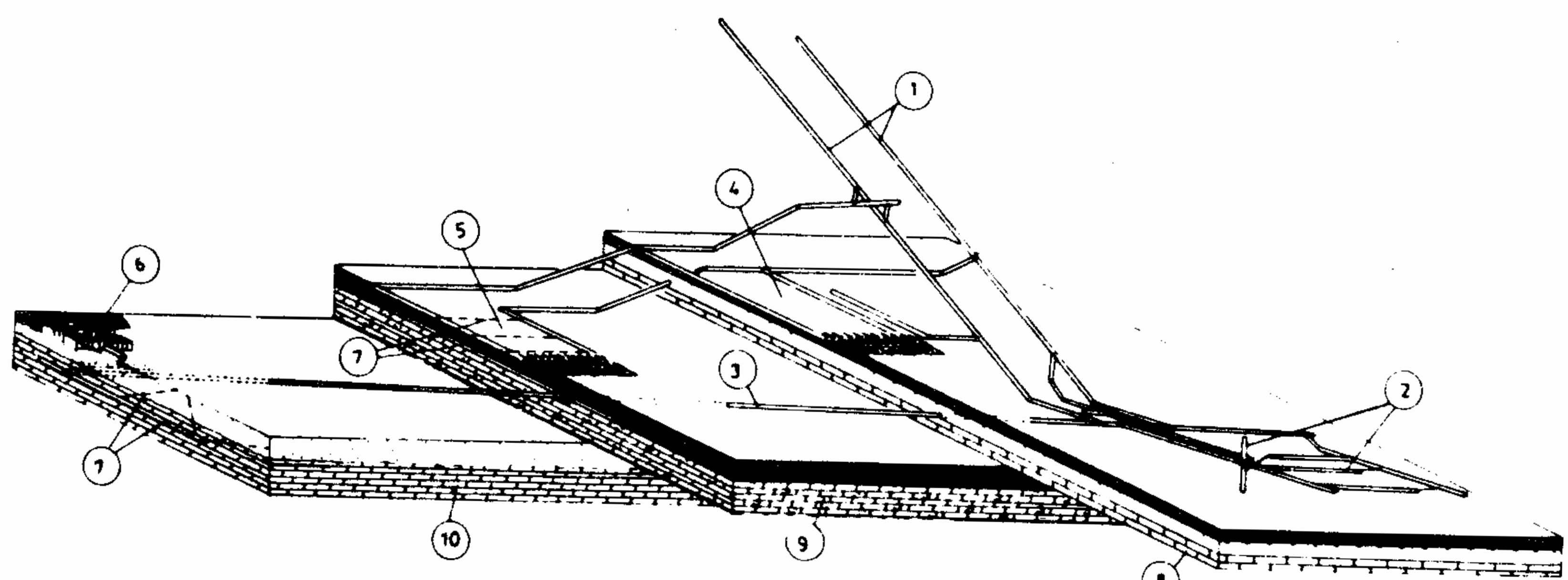

1 Főgerincvágatok Main drifts

2 Vizmentesitő telep Dewatering plant

3 Vizlevezető vágat Drainage drift

4 Felsőtelepi széntejtés Coal getting in upper seam

5 Alsótelepi széntejtés Coal getting in lower seam

6 Bauxittejtés Bauxite getting

7 Csapoló vágatok és fúrások Drainage drifts and drilling

8 Édesvizi mészkő Sweet water limestone

9 Áthalmozott dolomit Dolomite aggregation

10 Triász dolomit Triassic peroid dolomit