WATER CONTROL AT THE BAKONY BAUXITE MINES COMPANY

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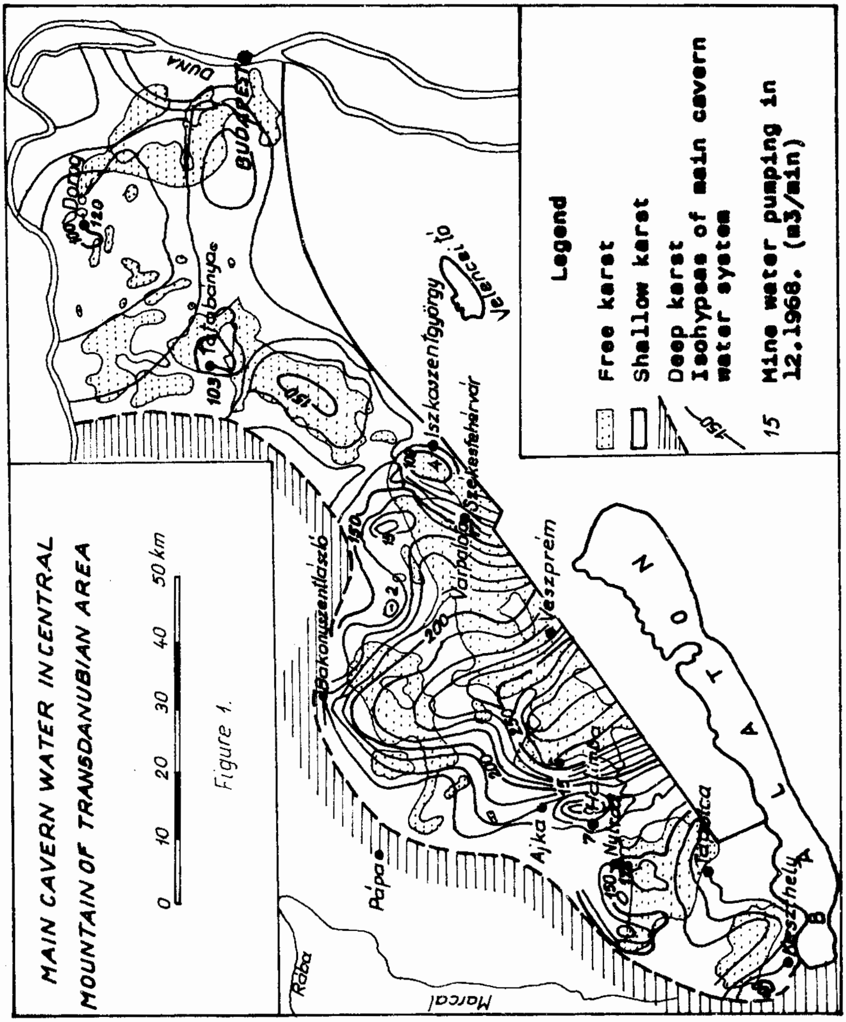
ABSTRACT

The Bakony Bauxite Mines Company fights against the impending hazards of water inrushes in underground working places in its mine at Nyirád through systematical water table sinking, the application of which expensive preventive method being necessitated by the existing hydrogeological conditions. The operation of the plant is being improved by the application of more and more up-to-date machinery and computerized controlling technique. The timely prediction and prevention of damages caused by drainage is also attended to, moreover, a considerable proportion of the water inevitably drained is being utilized for modern drinking water supply.

The Bakony Bauxite Mines Company functions in the vertical organization of the Hungarian Aluminium Trust. Its production makes up 2/3 of the bauxite production of Hungary. The proportion of deep mining is 70 %.

There is cavern water hazard in the subsurface mines. In the interest of the safety of mining, we are forced to lift 9 m3/min. water continuously in Halimba so 264 m3/min. water in Nyirád. The two mines are in different hydrogeological positions, and this determines the water-lifting requirement.

The mesozoic range of the Central Mountain Range of Transdanubia is built up of carbonate rocks of great thickness, which are highly tectonic and are karstic to a great depth. According to our experiences, the water stored in the formations older than the middle Cretaceous period constitutes a hydraulic system. This is called main cavern water, and it is represented as a contiguous water surface by isohypsas. Figure 1. This map reflects also the hydrogeographical situation. The ore stock of both of our mines is located on the mountain brow, beneath younger basin sediments. The underlying rock is a member of the mesozoic series of the Bakony Mountain. In Halimba, however, the water supply from the direction


MAIN CAVERN WATER IN CENTRAL
MOUNTAIN OF TRANSDANUBIAN AREA
0 10 20 30 40 50 km
Legend
Free karst
Shallow karst
Deep karst
Isohypses of main cavern water system
15 Mine water pumping in 12.1968. (m3/min)
DUNA
BUDAPEST
Dorog
Tatabánya
Iszkaszentgyörgy
Székesfehérvár
Velencei tó
Várpalota
Veszprém
Bakonyszentlászló
Ajka
Nyirád
Tapolca
Pápa
Rába
Marcal
BALATON
Figure 1.

of the Bakony Mountain is limted. The water-carryling capacity of the underlying rock can be characterized by a kM of 10^{-6}m2/s order of magnitude. The safety of production can be solved by passive water control. The plant prepares itself for 20 m3/min. maximum imbibition discharge.

The bauxite occurrence of Nyirád has a lense deposit. The main dolomite of the upper Triassic period, in the karstic indentations the bauxite lenses are situated, is covered with a thicker and thicker basin sediment on the mountain brow, with stepped subsidence. Thus, in the SW part of the basin the ore is on the surface, while in its NW part it is already at 200 m depth. We can see it on Figure 2. Typical gedogical section from the Nyirád bauxite area.

The original cavern water level was at about 25 m under the surface, at the +176 - 178 m level. After the exhaustion of the stocks near the surface, cavern water hazard had to be taken into account since the 1950's. The underlying rock of the bauxite lenses can be characterized by a water-carrying capacity of 10^{-2} m2/s order of magnitude. The overbuden series also consists of good aquiferous and water-bearing rocks, and it is in hydraulic connection with the main cavern water, which is made possible not only by the seam without impermeable stratum, but also by the good water-carrying capacity of the 30-50 m wide throw zones of the tectonism renewed in the younger orogenous movements.

It appeared that the supply from the precipitation falling in the karst areas of the Bakony Mountain was "unlimted".

The mining of the lenses in groups was most suitable for the points of view of the economic efficiency and technical development of mining. The mining of the four lense groups being situated higher has already been completed, while that of three lense groups is in progress. In the first phase of water level falling (as far as the +60 level), lense group 8 will not be developed, but the dewatering system developed in the whole basin is able to solve the task of water control is the next step, too.

Our water control system has been built continuously since 1966 on the basis of the results of the experiments started in 1963. The water-lifting facilities are large-diameter filtering wells, so-called drilled shafts. 34 drilled shafts have been established until now, and 24 of them can be operated economically at present, too. One of them can be seen on Figure 3. Drilling is performed by the plant established for this purpose, by a Wirth L 10 drilling machine. The starting diameter is 3200 mm, drilling penetrates into the main cavern water reservoir with 2000 mm diameter, into which a 1400 mm filtering pipe is located, while the annular space is filled with washed pearl gravel (Ø 6-12 mm). The technical stacks above the filtering pipe are closed steel casing pipes, which are cemented impermeably to the side wall. A mud trap is formed from an about 10 m long closed pipe at the bottom of the filtering pipe.

TYPICAL GEOLOGICAL SECTION FROM THE NYIRAD BAUXITE AREA

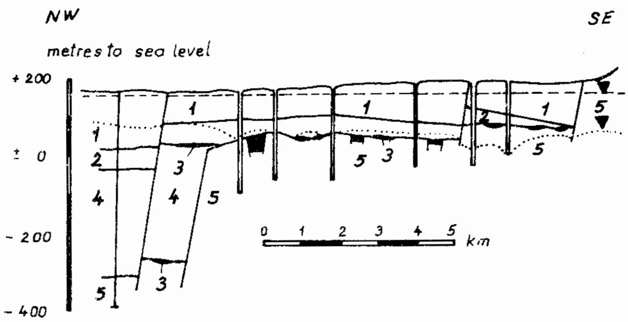


Figure 2.

1. Miocene rocks: limestone, sandstone, gravel, conglomerate, sand, clay
2. Eocene rocks: limestone, marl, clay
3. Bauxite
4. Upper-Cretaceous rocks: limestone, marl, clay
5. Upper-Trias rocks: dolomite, limestone

- Original karstic water level
- Karstic water level in Dec. 1984
- Dewatering well
- Borehole

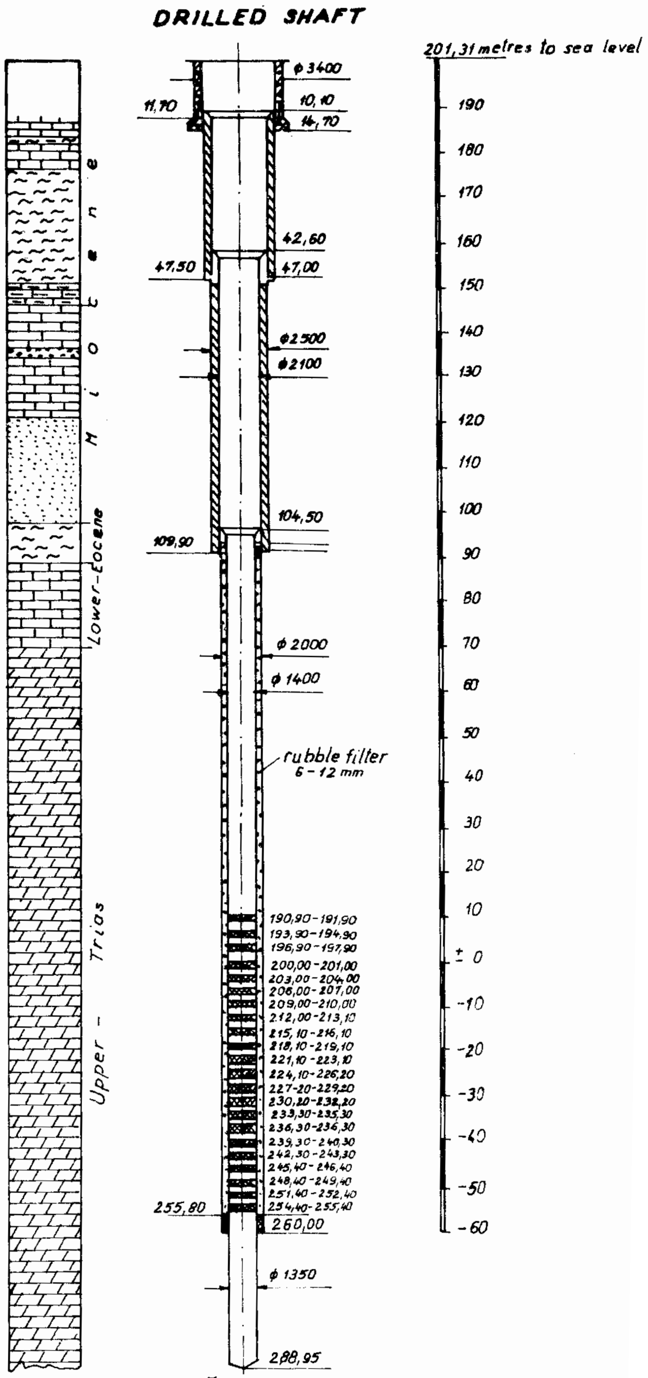

DRILLED SHAFT
201,31 metres to sea level
Miocene
Lower-Eocene
Upper - Trias
ϕ 3400
11,70
10,10
14,70
42,60
47,50
47,00
ϕ2500
ϕ2100
104,50
109,90
ϕ 2000
ϕ 1400
rubble filter
6 - 12 mm
190,90-191,90
193,90-194,90
196,90-197,90
200,00-201,00
203,00-204,00
206,00-207,00
209,00-210,00
212,00-213,10
215,10-216,10
218,10-219,10
221,10-223,10
224,10-226,20
227-20-229,20
230,20-232,20
233,30-235,30
236,30-236,30
239,30-240,30
242,30-243,30
245,40-246,40
248,40-249,40
251,40-252,40
254,40-255,40
255,80
260,00
ϕ 1350
288,95
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
± 0
-10
-20
-30
-40
-50
-60

Figure 3.

The following points of view are asserted during the location:

- the drilled shaft should be located in an area between lenses, outside the break boundary,
- it should penetrate to such a depth that an about 60 m long tapping section of its should always remain beneath the water level,
- in its lower section - as near to the bottom as possible - should cross a line of break,
- it should be possible to solve the possibility of drainage by gravity.

The lifting installations are West-German EMU-type plunger pumps with 7,5 m3/min. water delivery.

They are located in the shaft suspended on their pressure pipes. 3 of them can be placed beside each other in the Ø 1400 mm filtering pipe. 4 pumps operate suspended with twin mounting in our wells having the best water discharge. The pressure pipe is an ND 300, in the case of individual pumps, an ND 250 loose-flanged steel pipe. The lifted water is conducted through catchwater drains into an open receiver and through a pipeline to the feeding station of the regional water supply system, respectively.

The operation and control of the pumps is solved from a single centre through a telecommunication cable. The system is supervised by a pump operator in each shift.

We have been experimenting with data collection by computer since 1975. We connected a MINIDATA II-type data-collecting system to an EMG 666-type computer. This is able to receive 100 analogous measurements simultaneously, and at the instruction of the computer, it forwards them precisely measured to the computer. The systematization, storage and evaluation of the data take place according to the programme.

The MINIDATA measures the data of the measuring points every 20 seconds according to the setting of the quartz clock. The measurement data received at the 6 programmed steps are as follows:

1./ The produced water quantity of the drilled shaft
2./ Reserved for further development
3./ Water level of the drilled shaft in m
4./ Power consumption of machine 1
5./ Power consumption of machine 2
6./ Power consumption of machine 3

The computer records the data on a magnetic tape once every hour, evaluation takes place in the centre of the company every two weeks.

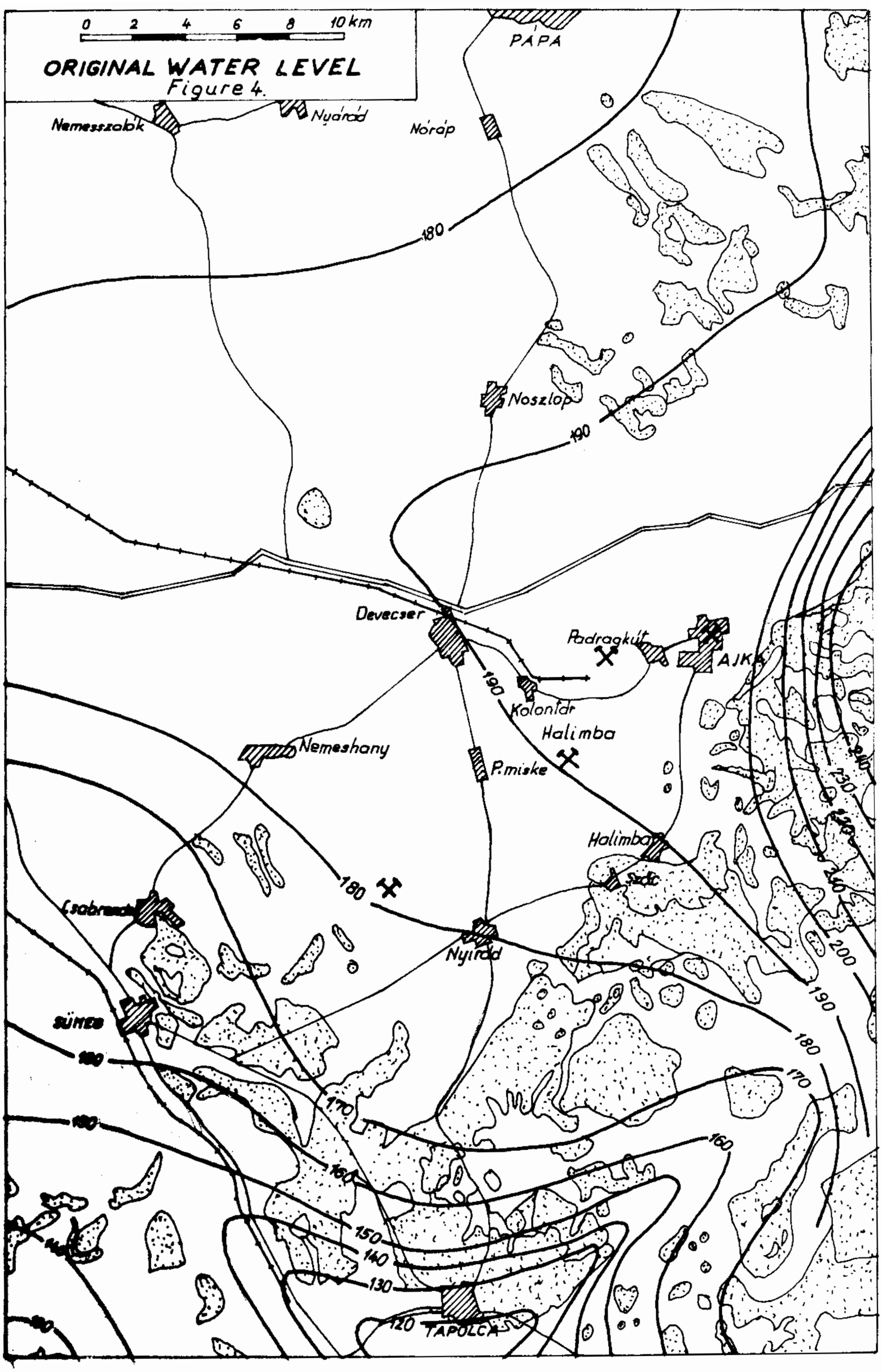
A VM 990-type equipment serves for immediate evalustion, which is built up with a microprocessor and displeys the measured results on a TV screen.

In the interest of smoot operation, module-type construction was applied, with interchangeable equipment.

We intend to purchase a new-type level-evaltuating probe for the measurement of the observation points, on the basis of experiences, which can be drawn from six months' plant experiments. The designer and manufacturer is the MYCROSYSTEM-Working Association. The automatic water level-recording system of the probe measures at adjustable intervals. It stires digital data in the field measuring and data-collecting unit. The data are recovered by a portable data recorder about every 2 weeks. The data recorded on the casette can be recorded on the computer for the purpose of evaluation.

Today we already know for certain that only the computer is suitable for the precise measurement, continuous control and processing of the operating characteristics of active dewatering. We must precisely follow the change of level occurring in consequence of water lifting and the economic effects of interference.

We have lifted 2,4 thousand million m3 of water until now. On the basis of the hydrogeographical situation, it is understandable that besides the approximately 115 m useful water level falling taking place in the inner area, a harmful water level falling has taken place in the more distant environment - having about 30 km radius -, which resulted in the drying-up of springs and wells. The exploration of the damages caused by water withdrawal, their prevention in good time are possible by means of continuous regional observation and by asking for expert opinions, and they are our important taks. The original water level can be seen on Figure 4 and the present water level on Figure 5. This large amount of pumping has caused a large-scale and relatively flat drawdrown curve. The difference map is on Fig. 6. In case the facilities of water acquisition are damaged, we compensate by connecting to a regional water supply system. (Fig. 7.) The rated capacity of the pipelines os 83,500 m3/day. Where this possibility of connection does not exist, the damage is averted by drilling wells or by deepening them further. There are, however, irreplaceable objects - medicinal baths - whose damage would exceed the extent of the tolerable damage. We must assess the extent of their effect exactly by the knowledge in our possession and by constant data evaluation.
Our water lifting can be not only operated economically by the well-controllable water intake system, but by the forecasting of the water level falling we are also able to minimize the quantity of water lifting ensuring the conditions of production. It is possible to mine not only safely, but also in a well-mechanized manner by falling below the production level. And the productivity of the most up-to-date mining methods offsets the expensiveness of dewatering.


0 2 4 6 8 10 km
ORIGINAL WATER LEVEL
Figure 4.
PÁPA
Nemesszalók
Nyárád
Nóráp
180
Noszlop
190
Devecser
Padragkút
AJKA
Kolontár
Halimba
Nemeshany
P.miske
Halimba
180
Csabrendek
Nyirád
SÜMEG
170
160
150
140
130
120
TAPOLCA
200
190
180
170
160

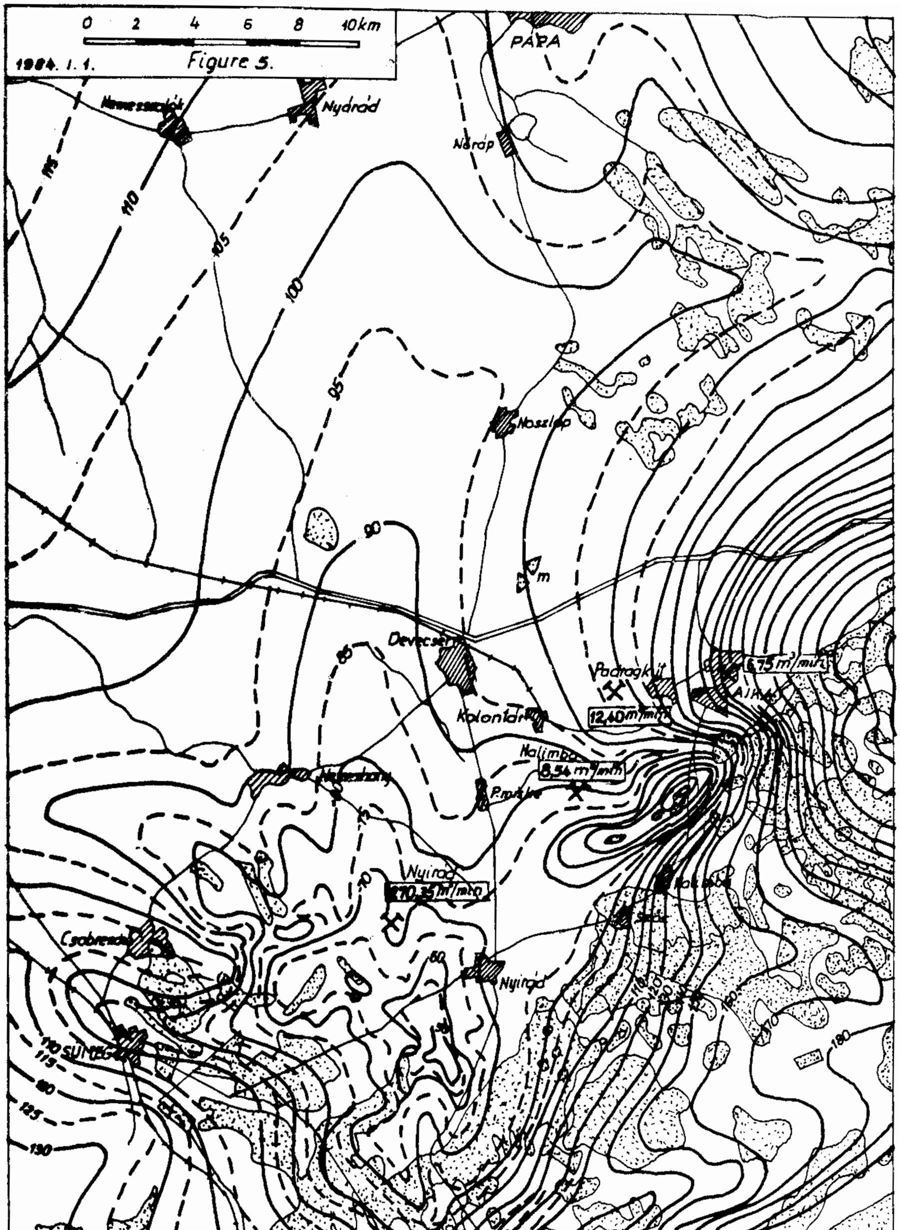
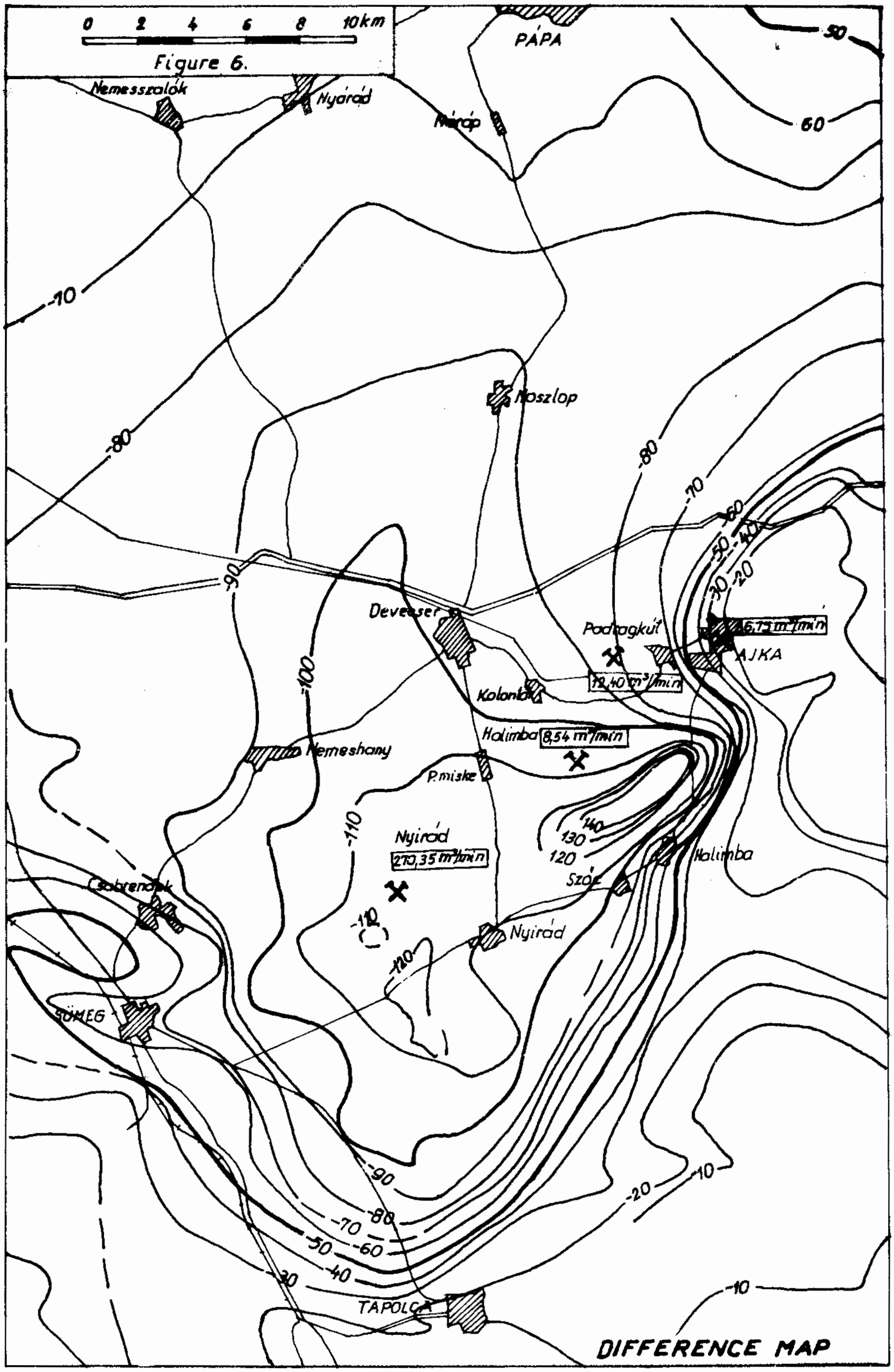
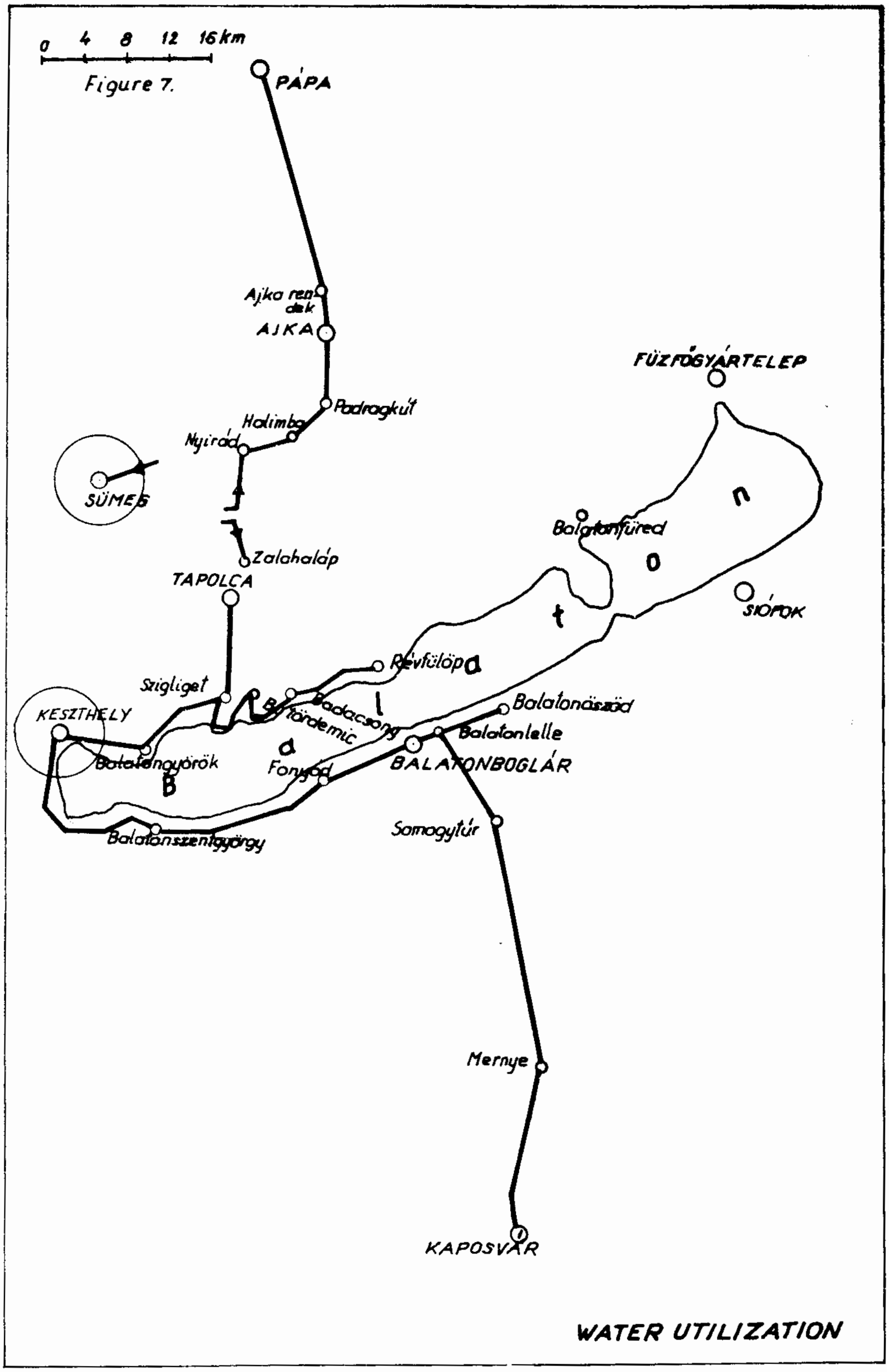

0 2 4 6 8 10km
1984. I. 1.
PÁPA
Nyárád
Nóráp
Noszlop
Devecser
Kolontár
Padragkút
12,40 m³/min
6,75 m³/min
Ajka
Halimba
8,54 m³/min
Nyirád
270,35 m³/min
Csabrendek
SÜMEG
TAPOLCA

Figure 5.


0 2 4 6 8 10km
Figure 6.
PÁPA
Nemesszalók
Nyárád
Noszlop
Devecser
Padragkút
AJKA
6,75 m³/min
12,40 m³/min
Kolontár
Halimba
8,54 m³/min
Nemeshany
P.miske
Nyirád
270,35 m³/min
Halimba
Szóc
Nyirád
Csabrendek
SÜMEG
TAPOLCA
DIFFERENCE MAP


0 4 8 12 16km
Figure 7.
PÁPA
Ajka rendek
AJKA
Padragkút
Halimba
Nyirád
SÜMEG
Zalahaláp
TAPOLCA
FÜZFŐGYÁRTELEP
Balatonfüred
SIÓFOK
Révfülöp
Szigliget
KESZTHELY
Badacsony
Balatonederics
Balatonakarattya
Balatonlelle
BALATONBOGLÁR
Balatongyörök
Fonyód
Balatonszentgyörgy
Somogytúr
B a l a t o n
Mernye
KAPOSVÁR
WATER UTILIZATION