# Impact of Deep Mine Dewatering on Groundwater Intake Located in Cap-Rock of Ore Deposit

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ABSTRACT

The impact of deep mining on groundwater intake from the cap-rock of a mine shaft is discussed. It has been proved that depression cause by mine drainage and by water intake superimpose, on each other.

## INTRODUCTION

Deep mine dewatering process induces changes in hydrogeological condition in mine under exploitation. These changes occur over large areas. First of all it is observed as a water level depletion. Results of mining drainage could also be impose in groundwater lowering by other engineering constructions also influencing natural groundwater condition. Water intake suplying with drinkable water could be this kind of construction.

Long-term analysis of dewatering in analysis of dewatering in deep-mine exploitaing copper in SW Poland indicates that one of the water intake is uned the influense. This was not predictable by water intake project neither nor by prognosis of mine activity. This paper is an attempt to evaluate of this phenomenon.

### Characteristic of groundwater intake.

Groundwater intake is located 1 km south-west from border of mine area and base od Tertiary water bearing strata, part of the thick overlying series of Cenozoic age which compose the cap-rock (fig 1). Water intake consist of five wells ranging from 180 m to 193 m which exploit water from a Tertiary aquifer located in inter-coal bed of Miocene age.

Evaluated and confirmated groundwaterb resources are rather samll and are estimated 120 m$^3$/h. Exploitation started from 1974-75 and is going till the present moment. In first asusmption water intake was designed as a temporarly source of drinkable water for a city of mine area. At the present moment it is not considerate as under liquidation. Until 1980 water extraction have been as evaluated resource, since this date a decrease about 20-30 % was

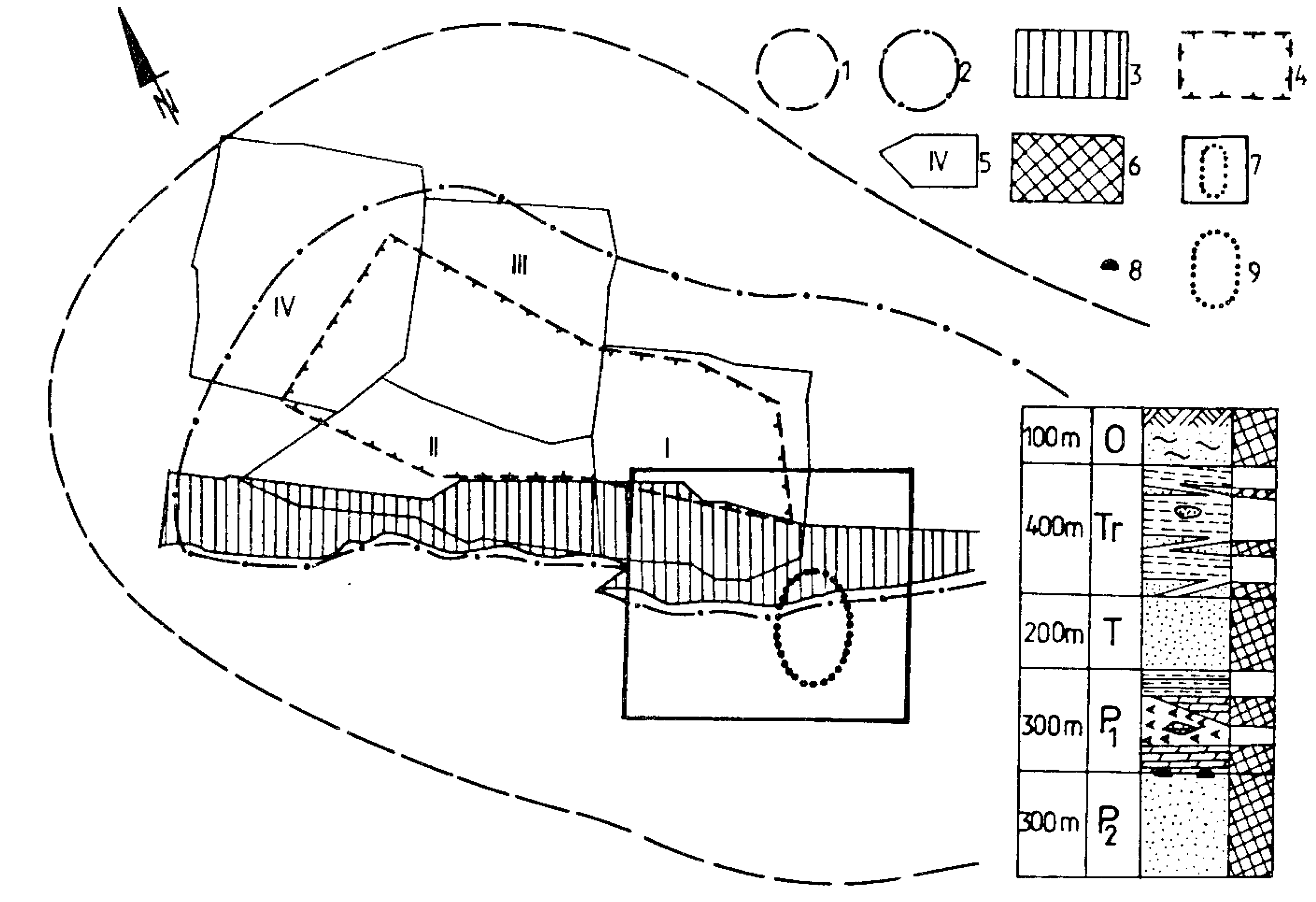



Figure 1. Scheme of hydrodynamic conditions and litho-stratigraphic column
1 - Range of cone of depression in Tertiary inter-coal sands horizon, 2 - Range of cone of depression Zechstein limestones horizon, 3 - Zone of hydraulic contacts between aquifers, 4 - Zone of drainage, 5 - The mine area, 6 - aquifer, 7 - Region of groundwater intake on figure 2, 8 - Mine working tunnels, 9 - Cone of depression resulfing from water intake exploitation.

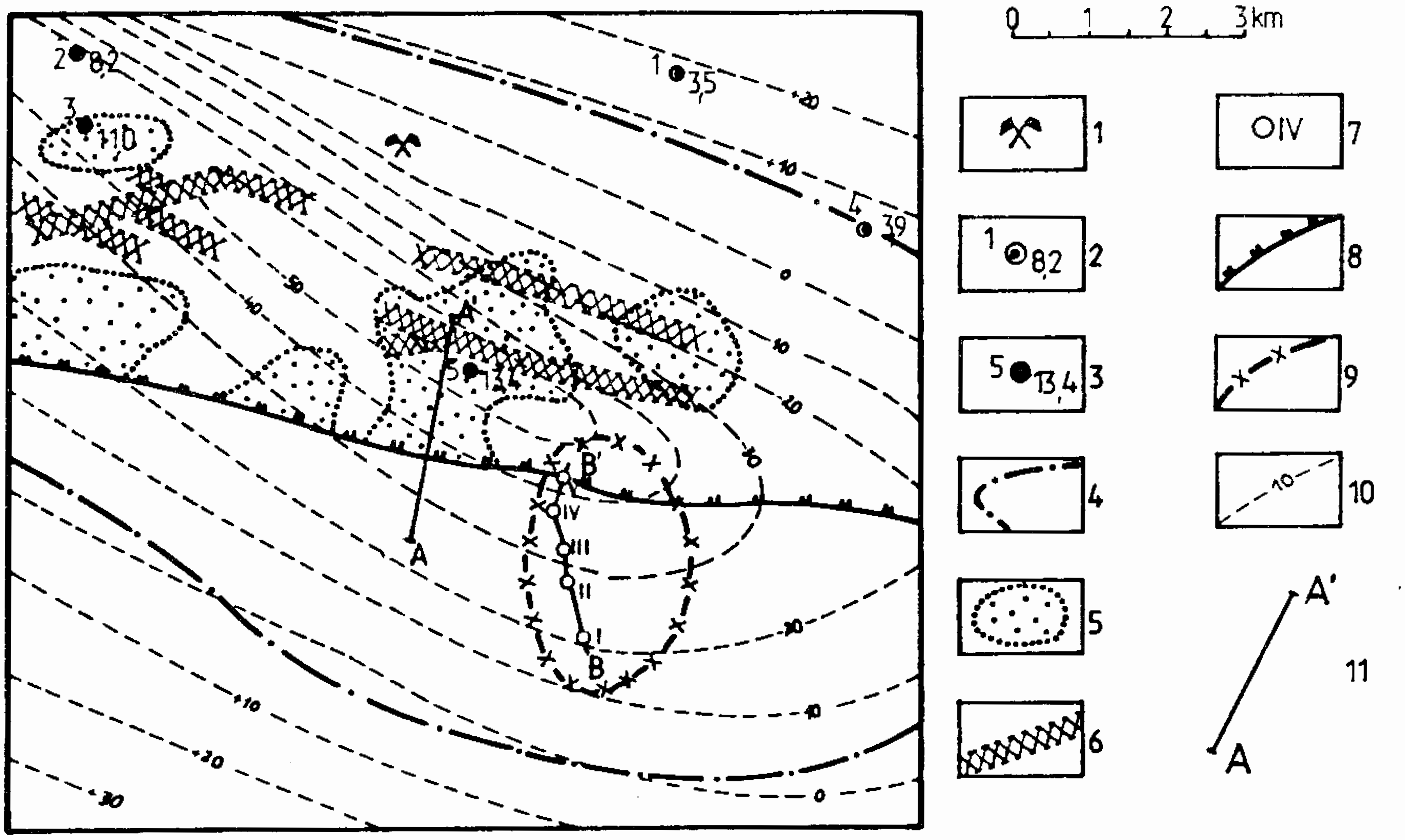



Figure 2. Hydrodynamical conditions in the top and middle of Tertiary formation in the neighbourhood of groundwater intake 1 - mine shaft, 2 - Observation well in inter-coal water - bearing aquifer, 3 - Observation well in under-coal aquifer, number of observation well and depression in m, 4 - Depression zone over 4m in inter coal-aquifer, 5 - Sedimentational - hydraulic contact between Tertiary deposits and deeper aquifer, 6 - Tectonical - hydraulic contact as above, 7 - Wells intakes, 8 - Limestone and Zechstein dolomite bed boundary, 9 - Zone of intake impact, 10 - Piezometric contour line of under-coal aquifer, 11 - Geological cross-section lines

observed.

## Hydrogeological conditions

Copper ore deposits are located in sissured rock of Permian age at depths of 700-1200 m. Mentioned water intake is located in water-bearing strata within Tertiary aquifer which is at depths of 180-200 m. There are some other aquifers between dewatering ore deposits complex and Tertiary formation where water intake is located. Multi-layered system of aquifers and aquitards is a specific feature of hydrogeological condition in this area (fig.3a).

Tertiary aquifers system in t his region of copper ore deposits is represented by sands and gravel forming lenticles and continuous layers isolated with clay, claystone and brown coal. Coarse composition of sand and gravel is variable (fig.3b). Boundaries between aquitards, aquifuge and aquiclude are not sharp. Lenticles and layers of permeable material connect each other through low permeable material and acquiclude. High litological differenciation of Tertiary formation in profile as in horizontal range makes it difficult to correct localization of aquifer within Tertiary water-bearing system(1).

In general in litological varying complex of Tertiary formation a three confined aquifer are distinguished:

1. over-coal aquifer located in Tertiary complex at the depths from hundred and several dozen meter below surface and thickness more than ten metres. Water level is stabilized at depth of 150 m a.s.l.

2. inter-coal aquifer in the middle part of Tertiary formation at the depths of two hundred and several dozen metres and water level is stabilized at 110 m a.s.l.

3. under-coal aquifer in floor part of Tertiary complex, at depths of three hundred and several dozen metres, with thickness up to several dozen metres. Piezometric water level is tabilized about 78 m a.s.l. Inter-coal aquifer in a place where water intake is localized is build up with sandy gravel and sandy-dust sediments with sandwater character. Sands and gravel coarse grain however its thickness is rather small are preffered way of groundwater flow and are utilized for supplying drinkable water. Average thickness of this aquifer is about 20 m. Average hydraulic condustivity for mentioned prefered layer designed by Theis method is about 55 m/day, when for whole aquifer together with sandy-dust sediment ranging from 2 to 17 m/day. Over the aquifer roof and below there are clay and sandy clay with thickness several dozen metres. Analysing the chemical composition of graoudwater under exploitation it was observed a stable composition for a long period. It is prove of good confining inter-coal aquifer from others and difficult contition of recharge. The same conclusion comes from the observation of a very slow rise in cone of depression after the pumping collective test, before the water intake have been prepared for exploitation. During this test a stable condition of inflow was reach. Also systematic falling down of pumping rate during experiment indicates low value of groundwater renovation in this aquifer.

Dewatering process of ore formation in the neighbourhood of water intake is continuing for 26 year and resulting in deep change of hydrogeological conditions all over the cap-rock (1,2). After three years of mining activity drainage of Tertiary formation have started. Firstly the under-coal aquifer has been influenced by mine cone of depression affecting Tertiary under-coal aquifer shown by piezometric levels of Tertiary under-coal aquifer. Zone of the biggest depression of piezometric level in this aquifer indicates 5 piezometer located a few kilometres north-west from water intake under consideration (fig.2). Depression of piezometric level in this point at he present moment is about 145 m. Piezometric water level of under-coal aquifer in area of mentioned water intake is illustrated on fif. 2.

From analysis of geological and hydrogeological situation it is evident that the zone of maximum depression of water level in coal aquifer covers with zone of hydraulic contact between aquifer located in Permian limestone and dolomite dewatering by mine excavation and Tertiary aquifers.

In ninth year of mine formation drainage was observed weekly tendency of the depression creation in inter-coal aquifer. In the same time started work a water intake. However the changes in piezometric water lowering have not been noticed in this area. At the present moment the etendency of piezometric level depression creation in this aquifer by mine ativity is quite clear.

Decrease of water level in piezometeres bottoming in inter-coal aquifer adjacent to water intake are as follow: 1 - 3.5 m, 4 - 3.9 m, 2 - 8.2 m, 3 - 11,0 m. The zone of lowering water level in inter-coal aquifer covers with area of maximum depression in under-coal aquifer. This is a result of profound groundwater seepage in Tertiary complex under the lowering hydraulic head in lower part of formation (under-coal aquifer).

**Impact of mine drainage on exploitation of water intake**

Dewatering of formation by copper mine has been going for 26 year. Water intake has been working for 17 years. Prognosis calculation of depression for water intake when water exploitation is about 90 $m^3$/hour indicates it should be after 17 year about $S_u = 4$ m. During the period from 9 to 17 years of water intake activity a regular observation of piezometric surface have been done in inter-coal aquifer. Base on this observation it was stated that after 17-year of activity, with constant pumping rate about 90 $m^3$/hour the depression is almost three times more than prognosis and is equal $S_w = 14$ m.

The tendency of increase the depression is observed. This phenomena could be explain by superposition of depression involved by water intake with depression due to formation drainage by deep mine dewatering. Base on the data from mine observation network of piezometric level of aquifer under consideration only under influence by mine in this area indicates depression $S_k = 10$ m (fig.4).

Total depletion noticed din piezometers of water intake was 14 m. Its value is equal to sum of depression induced by mine activity and water intake and is equal:

$$S_w = S_k + S_u = 14 \text{ m}$$

The value of second component of this sum is estimated base on prognostic calculation when groundwater resources of this aquifer are limited.

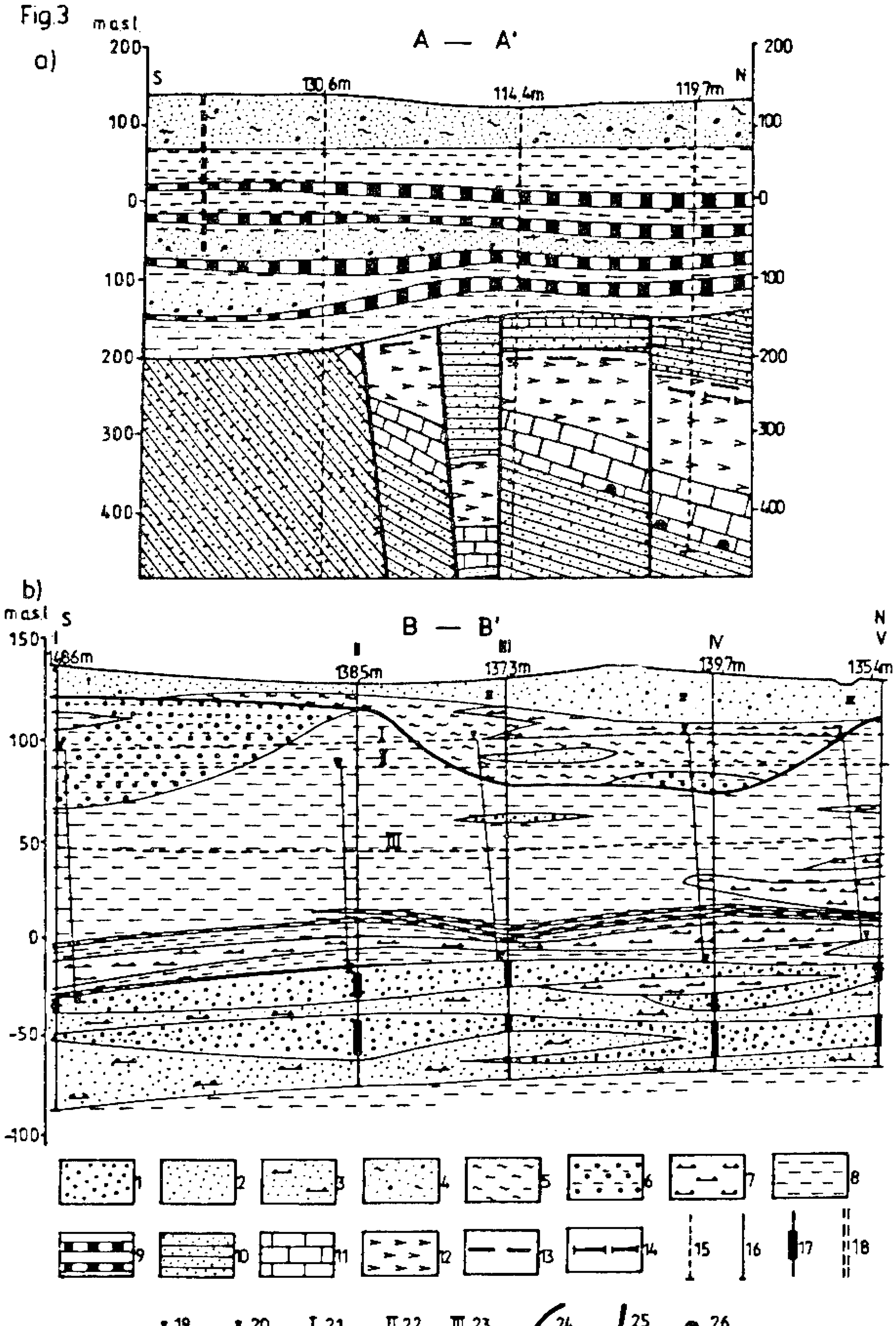
Interpolating the obtained results of water level in water intake area for coming several years it is possible to state that exploitaing groundwater resources will not be disturbed. This situation could change unprofitable following rapid hydrogeological changes in area of water intake. This situation could occur if mine drainage becomes more intensive in nearest zone of

Figure 3.a) Geological cross-section A - A' though sedimentary complex in the region of copper ore deposit

b) Hydrogeological cross-section B - B' though the top and middle part of Tertiary formation in the neighbourhood of groundwater intake

1 - Gravel, 2 - Sand, 3 - Flour sand, 4 - Vari-size grained sand, 5 - Clay, 6 - Grit, 7 - Dust, 8 - Argil, 9 - Brown coal, 10 - Sandstone, 11 - Limestone and dolomite, 12 - Anhydrite, 13 - Schist, 14 - Dusty dolomite with schist, 15 - Well, 16 - Groundwater well, 17 - Well filtered zone, 18 - Groundwater level, 21 - Static, original groundwater level, 22 - Dynamic groundwater level after 4 years intake work, 23 - Dynamic groundwater level with maximal exploatational depression, 24 - Border between Tertiary and Quartenary deposits, 25 - faults, 26 - mine works.

Fig.3



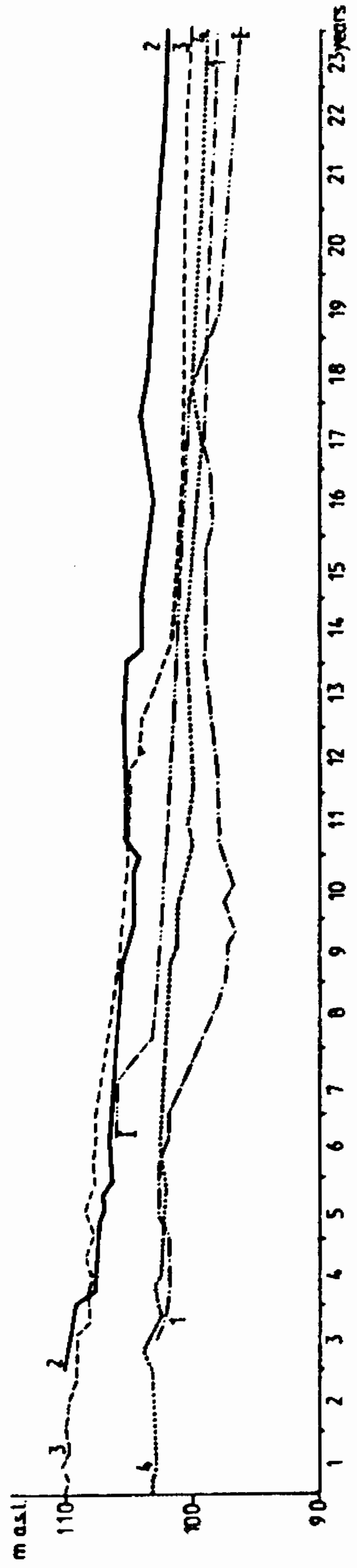



Figure 4. Lowering of groundwater level in observation wells of inter-coal aquifer.

intake or when exploitation of brown coal Tertiary origin could be started in distance 20 km south of intake. In 20th year of copper ore mine drainage a schame for the hydrogeological condition was prepeared. Base on modelling technique relative to prognosis of inflow into ore formation parameters of vertical percolation through semipermeable layer has been evaluated(2).

The value of seepage coefficient of confining Tertiary beds, separating inter-coal and under-coal was evaluated as $\alpha = 10^{-7}$. At that time there was not the advantage of measurement of piezometric levels in the inter-coal aquifer. At the present moment, after 26-years of drainage system activity calculating scheme was complemented by new data about depression of water level in a zone of water intake activity what allows to evaluated this coefficient as value $\alpha = 10^{-6}$. Differences in the order of magnitude could be due to over simplification during preperation in the scheme eof hydrogeological conditions for inflow prognosis.

It must be accept that in areas of mining drainage with increase of activity the hydrogeological parameters could change.

At the present moment observations of behaviour of the piezometric surface are continuing in areas of water intake and further is being prepared for repeat modelling.

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