CAPTURE POSSIBILITIES OF INFILTRATION WATERS ABOVE SALT ROCK DEPOSIT IN TUZLA BY EXISTENT PRODUCTION WELLS IN DISTRICT "HUKALO-TRNOVAC"

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ABSTRACT

In south-east shallows part of rock salt deposit "Tušanj" in application is the brine pumping by deep wells (uncontrolled leaching method), which started 110 year ago. In this area there had been concentrated many deep wells, which performs the exploitation by pumping of brine (with over 300 mg/l mineralisation), formed by peripheral fresh water infiltration and salt layers dissolution in deposit.

In consequences of salt leeching and salt water pumping during a long time period, appears the surface sinking process (subsidence) with very hard consequences on surface area of the town Tuzla.

Daily water inflow into deposit area amounts 3.000-4.000 m^3, but daily production demands in last time are lower. This difference is the cause of groundwater level and hydrostatic pressure increase, what make dangerous for shafts stability.

In order to retain groundwater level within safety limits but without useless salt leaching, it is better fresh water perform extracting before salt deposit.

One of these possibilities is the infiltration water pumping in the peripheral shallows area of fracture-Karstic groundwater before to leaching process beginning.

The existing exploitation wells in this area for this undertaking are suitable, but with certain reconstruction. This reconstruction understand the well capture part change and casing perforation.

In this paper the well reconstruction possibilities for mentioned undertaking and his efficiacy are described.

INTRODUCTION

The brine extraction in the salt rock deposit in Tuzla lasts of the end of XIX centenary till now. Building now processing capacities the brine exploitation had reached to 2,5 mil m^3 per year, what for the consequence had a intensified surface subsidence and a continues lowering of underground water level (GWL) in deposit. By introducing the methods of controlled leaching from the mine Tušanj, the brine pumping by the uncontrolled leaching is reduced for 60 %, what caused a reduced

subsidence and a continuos raising of GWL in deposit. In last five years, because of war activities, the brine pumping by uncontrolled exploitation method is more reduced, as because of shortage of pumps as also because the brine users can not sell all their products. As a consequence GWL faster increases as also the hydrostatic pressure on the living of the hoisting shaft which is located on the leached limit of the deposit.

To prevent further increase of GWL and the pressure on the hoisting shaft construction it is necessary to pump the brine from the deposit the quantity 3000 - 4000 m^3 per day.

In this work is presented a method how it is possible with a rational pumping of above salt waters to reduce subsidence, keep GWL and lower the pressure on the hoisting shaft construction and to protect salt rock reserves.

THE HISTORY OF DEPOSIT EXPLORATION AND EXPLOITATION

Many explorers studied the salt rock deposit in Tuzla The first data on geological characteristics for the deposit are found in works by Katzer in 1917 and 1921, and later by M. Luković 1951 and 1952, P. Stevanović and M. Eremija 1958, I. Soklić 1961 and 1964, and the first hydrogeological date on the deposit and environment are found in unpublished works by M. Luković 1952, D. Patri 1956, J. Baturić 1961, A. Mizi 1961 and in published work by P. Miletić 1958.

Detailed geological and hydrogeological investigations started at end of sixties and at beginning of seventies by the investigating team of Geological Department of Salt Mine "Tušanj" and "Geoinžinjering" from Sarajevo. Among them are significant numerous published as unpublished works by P. Jovanović, M. Vujović, J. Stojković, M. Vuković, N. Djurić, Z. Brajković, S. Vrabac, Dž. Bijedić et all.

The exploitation of the salt rock deposit in Tuzla lasts some centuries. At the beginning the brine was taken in digged wells and from 1885 by deep wells from the surface. This method known as a "method uncontrolled exploitation" because it is not possible to control which part of the deposit is leached. It is based on taking underground waters that have been in contact with salt body, leaching it and saturated with salt. Therewith the leached rooms of great dimensions are created in which the root caves and with this the surface subsidence. The surface subsidence caused many unfavorable effects as for the exploitation so also for the city part which is situated on southern deposit rim.

The methods of exploitation at the time were not at the level of actual technologies, they produced the brine in the cheapest way not considering the consequences of such a work. An intention to open a mine by sinking a shaft at end of XIX century in Trnovac area was unsuccess full, because it failed to sink the shaft through the waterbearing sediments.

After the II world war it was undertaken again to sink shaft but in other part of the deposit, in Tušanj area. The shaft sinking was very slow because of the difficulties to sink through waterbearing sediments. Only by the freezing the water bearing zone the shafts were sunken and the deposit is devided in two exploitation fields: exploitation field Hukalo-Trnovac, where the exploitation is by deep wells from surface, and the exploitation Tušanj where the exploitation is by underground mining. Between these two fields a protecting pillar 200 m wide (Fig 1) is left.

GENERAL GEOLOGICAL AND HYDROGEOLOGICAL DATA

The rock salt deposit in Tuzla, seen on the whole, has a syncline form with the axis inclined to NW at an angle 10-15^0. Its area is 1,8 km^2, and is extend under the northern part of the town Tuzla.

Genetically seen the salt deposit is of the sedimentary origin created in a process of chemical sedimentation of lagoon type. In rock salt seams there are stratified seams and intercalations of marl, claystone, anhydrite, genordite and gypsum, seen. In the deposit 5 salt series are recognized which ? in a vertical section are named I; II, III B, III A and IV (Fig 2). they are lying as bandmarls, intermittently as dolomitic

In the bottom of I saltseries is volcanic tuffite seam so called "pelit" some meters thick (Pelit is a local name for a claylyhalitic quartzitic tuffite). It is an impermeable rock in conditions with the waterexchange it is degraded (the halite veins are dissolved) and acts as a permeable rock.

Above the saltseries are slir sediments which are presented with marls, claystone and interseams of fine-grained sandstone. Slir sediments are partially permeable and their thickness is from 150 m in SE deposit part to 600 m in NW deposit part.

In saltseries are bandseries (marls and claystone) of impermeable rock and in zones where are degraded they present permeable rock.

Under the saltseries are sandstones, alevrolites, marls, claystones and sandy limestones known under the name "red series" that in hydrogeological consideration present a complex.

Southwestern deposit vi are unpermeable anhydritic breccia masses.

In northern and northeastern deposit part in which the salt is leached there are very permeable marly breccia from caving, which laterally are represented by permeable sedimentary complex consisting from marls, degraded pelite, anhydrite, and calcarenous marls, known as " Tuzla plate limestone" (Fig 5a).

The groundwater inflow is tiough above named sediments from the alluvion of rivers Jala and Solina. The daily inflow is 3000 - 4000 m^3 what is necessary to evacuate to keep the reached GWL.

By evacuating 1m^3 of brine mineralized by 310 kg/m^3 a void of 0,145 m^3 is created what causes roof sediments caving in.

Long duration exploitation caused the leaching of the most part of I saltseries and a movement of northeastern limit of deposit to the deposit middle.

PRINCIPLE OF THE WELLS WORK

The exploitation of the brine in deposit is based on pumping by wells the water infiltrated in salt deposit.

The water movement in Well zones is along the contact of I, relatively II saltseries and the bandmarls overlaying above them. The water on its way to the wells leaches II saltseries and the remnants of I series, which are as shallowest ones leached in NE and SE deposit part. In leaching process of I series, its bottom "pelit" (quarzite-clayly halitic tuff) containing a high salt percentage (44 %) is leached, what causes an occurrence of marly pelit breccia which has a good permeability. By leaching of I, II and other salt series as also of roof sediments a breccia is created by caving in and it represents a fracture-carstic zone. The water is on its way to the well partially salty and in the well zone moves to lower part of the well. Because the thickness of the II series is to 300 m (depending on the position relatively to the syncline bottom, unsaturated brine leaches in its movement the salt, reaching a concentration of cca 310 g/l. By the intensive brine pumping on some wells the leached room is increased and the consolidation of roof sediments is prevented and in the same time the fracture-carstic zone is maintained. By the brine pumping the cylindrical room in the freacture-carstic zone partially is spread in roof sediments (Fig 3).

WELL CONSTRUCTION CHARACTERISTICS

The brine exploitation by deep wells from terrain surface from the end of last century had no essential changes (Fig 3).

During the drilling the wells are lined with a casing, the guide casing is built to the roof marls. The casing is bottom is perforated in a length of cca 10 m before it is built in place.

The upper exploitation tube is built to the roof (of middle) part of II saltseries. The tube bottom is also perforated in a length of 10 m or more.

The lower exploitation tube is built in these tubes with the tube month in the interval from the deposit roof to the roof of II saltseries. The tube is with funnel mouth or with a built in rubber packer to prevent an in flow of the unsaturated brine from the deposit roof in the exploitation tube. The lower part of the tube is "reduced" and this tube in the lower part is perforated in a length of cca 50 m and performs as a settling.

A submersible pump "Pleuger" is built is built in the well, sunk in the brine and pumps it in a reservoir on the surface from which it is distributed consumers.

POSSIBILITY TO PUMP THE WATERS ABOVE SALT TO CONTROL GROUNDWATER LEVEL IN DEPOSIT

Because the necessary quantity of brine for processing is reduced and this quantity is less than the necessary one to keep GWL (3000 - 4000 m^3) on a safe level, it is foreseen to realize the difference of these quantities by pumping the waters above the salt (low mineralized) in roof of the deposit (Fig 5)

Considering the named principle of well function, the data on the well construction as the hydrogeologic conditions in the deposit it was determined that the waters salinity increases. Namely in roof part of II saltseries, in fracture-carstic zone, if prevented contact of underground water with rock salt and also because of a low mixing with the brine (reason of different specific masses of water and brine) the water is low mineralized. By pumping this low mineralized water from this level to control the level it would be significantly reduced unnecessary leaching of the salt.

To create the conditions for this purpose it is necessary to perforate protecting casing and upper exploitation tube in the immediate roof of I saltseries, in fracture-carstic zone, and to install the pump in perforation zone. With the installing the pump it is also necessary, with the packer, to isolate lower part of the well construction in order to prevent to pump the saturated brine. The same effect will be realized by building new wells on the deposit part deeply to the level of dissolved I saltseries (Fig 4 b).

EFFECTS TO EXPECTED

Applying this method of capturing the waters above the salt deposit it is possible to expect many effects as are:

-a reduced subsidence intensity and reduced damages on existing objects on the subsiding area. By capturing 1000 m^3 of underground water a deficit of cca 145 m^3 salt mass is saved and with that the cause of the roof masses and surface subsidence,

-underground water level and hydrostatic pressure on the hoisting shaft living will be kept on a safe level,

-the geological salt reserves will be saved

-the pump lifetime will increased because the medium is less aggressive and specific ..? of the water (very low mineralized) is for cca 20 % less then of the brine,

-the pump capacity will be increased and the electricity consumption reduced.

CONCLUSIONS

Long-lasting reduction of the production in the brine, this production is less than the inflow of groundwaters, causes an increase of underground water level and endangers?? The stability of hoisting shaft as the same mine Tušanj. In the next period it is not to expect any increase brine production because the processing in factories is reduced.

- An analysis of the wells operation, of geological and hydrogeological data as also experimental data indicate on the fact that surface waters infiltrating in deposit have a low mineralization before they come in contact with salt mass. These over salt waters realize a contact with salt mass in deeper part of fracture-carstic zone.
- To prevent the further increase of underground water level, to reduce an unnecessary exploitation of the brine as the subsidence of roof sediments and of the surface, it is necessary to perforate the existing wells immediately above II saltseries and to pump low mineralized over salt waters from deposit or to build new wells to capture these waters.

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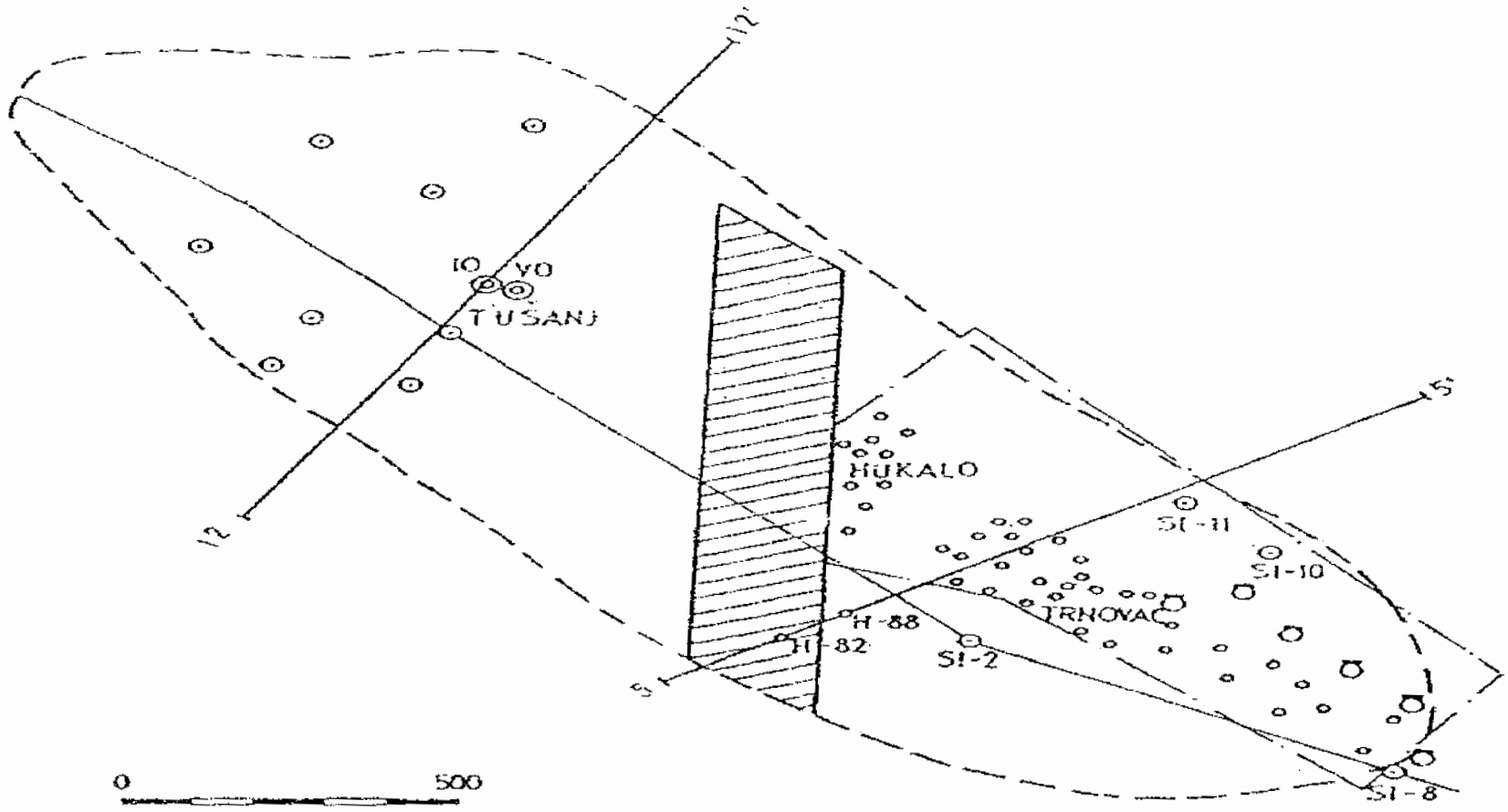


Fig. 1. ROCK SALT DEPOSIT IN TUSSLE
1. Deposit boundary
2. Limit of exploitation field "Hukalo-Tmovac"
3. Safety pillar
4. Cross section lines
5. Old and new exploitation wells
6. Investigation holes
7. Hoisting and ventilating shafts

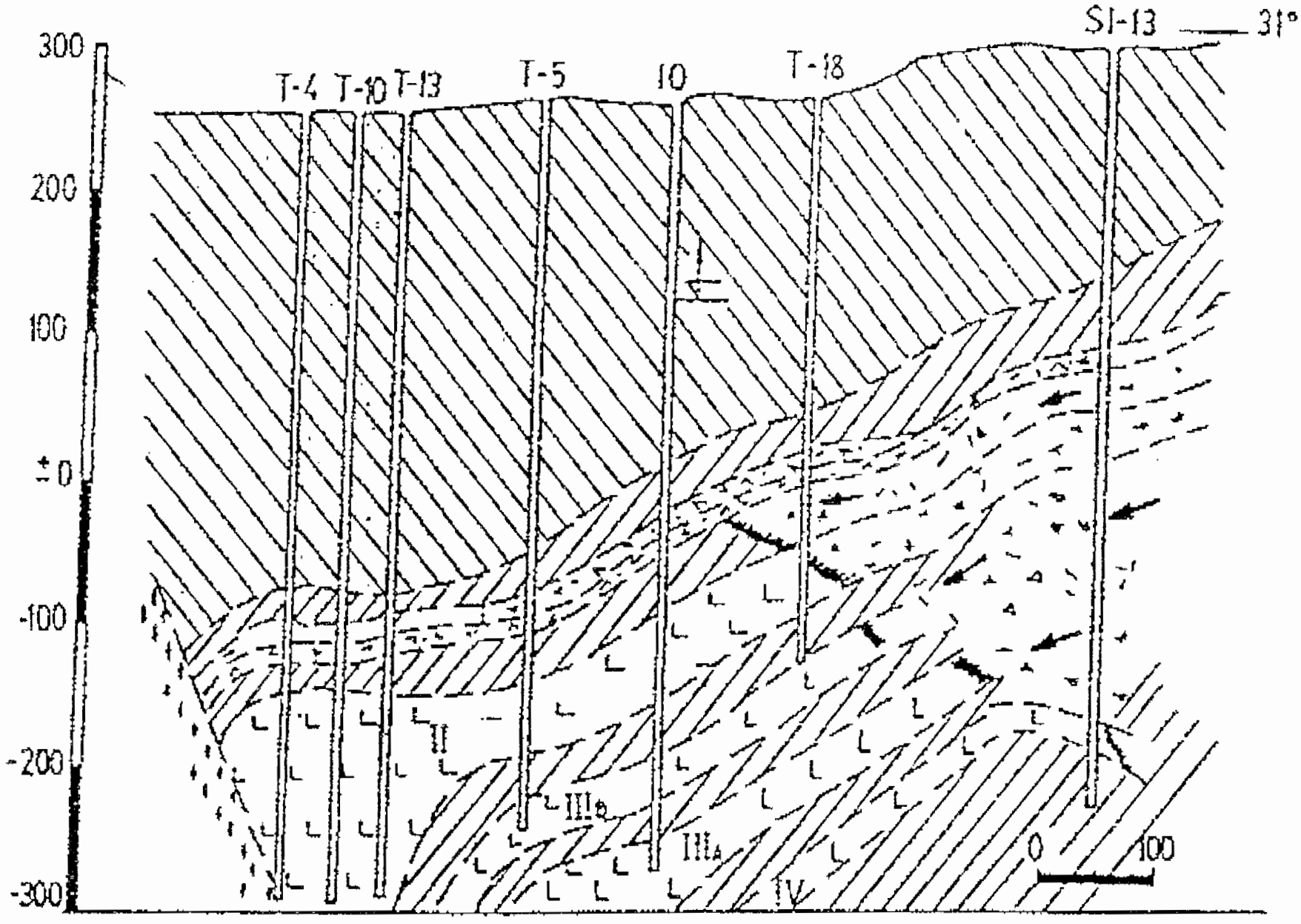


Fig. 2. HIDROGEOLOGIC CROSS SECTION

(By J. Stojković, N. Đurić)

1. Torton slir (marl, clay, sandstone)-HG insulator,
2. Banded series (marl, claystone)-HG insulator; option HG collector
3. Pelit (quartzite clayly. halitic)- HG insulator, option HG collector
4. Salt series: I, II, IIIB, IIIA and IV
5. Anhydrite,- HG insulator
6. Products of lateral leaching of salt series, option HG collector
7. Supposed leaching limits of salt series
8. Direction of groundwater flow
9. Groundwater level (GWL)

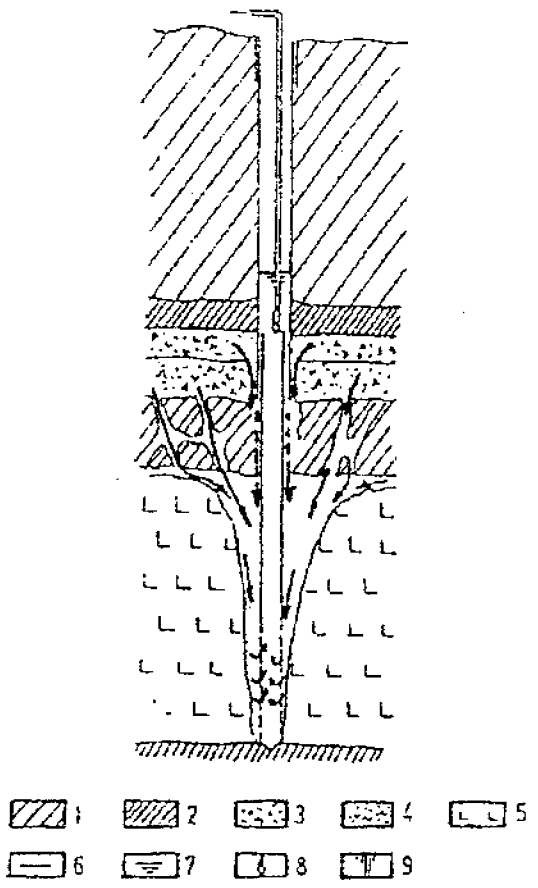
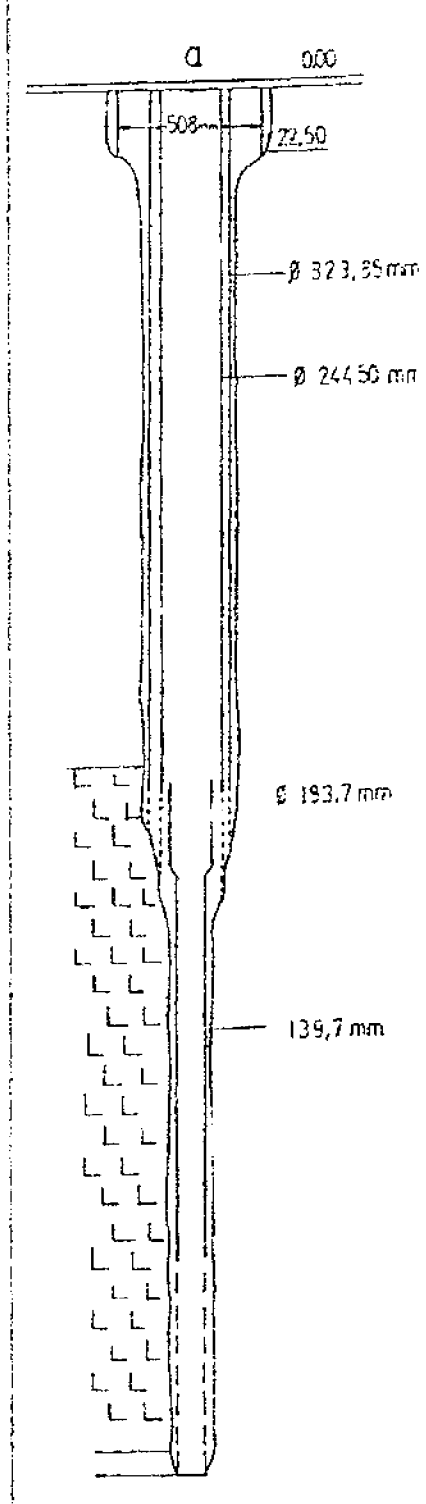
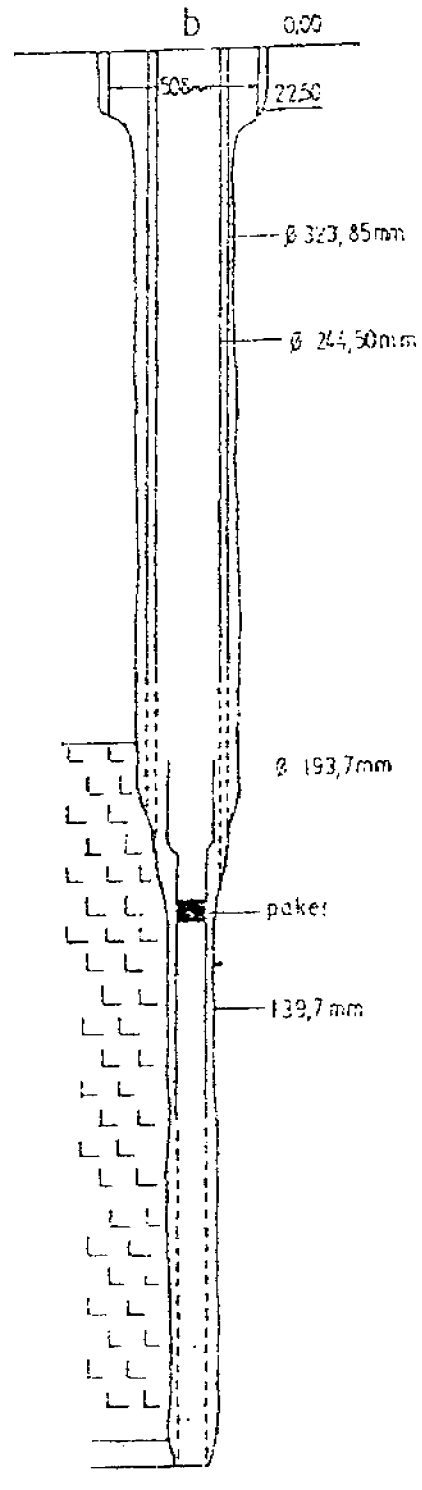


Fig. 3. SALTWATER WELL IN UNCONTROLLED LEACHING METHOD

1. Slir
2. Band marl
3. Breccia
4. Pelit
5. Salt
6. Direction of groundwater flow
7. Groundwater level
8. Submerible pump
9. Well of tubing



a) in origin



b) after perforation

Fig. 4. WELL CONSTRUCTION

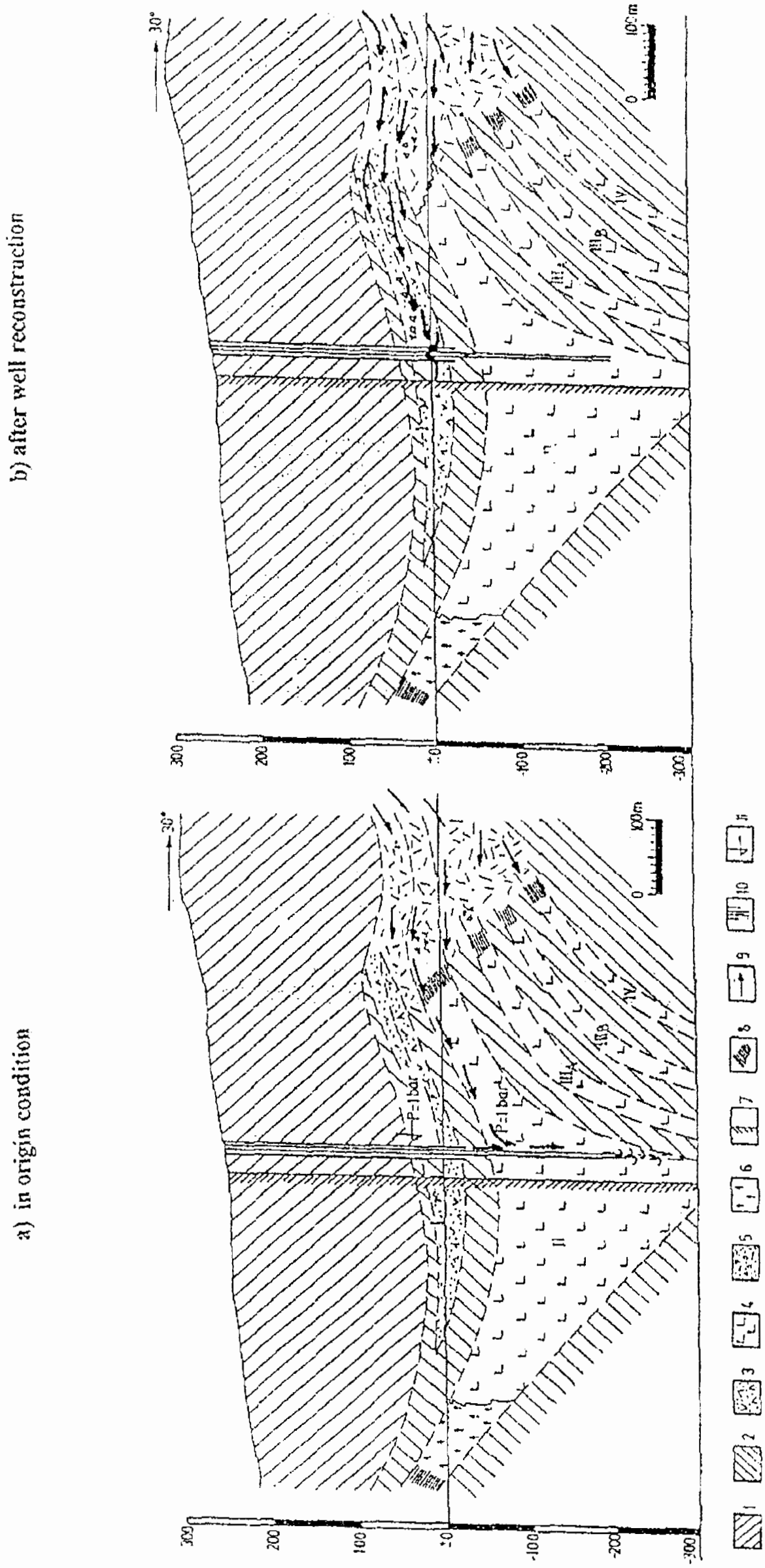


Fig. 5. GROUNDWATER FLOW DIRECTION TO WELL
(cross section 5-5)

1. Slir
2. Band marl
3. Pelit
4. Salt
5. Marly breccia
6. Anhydrite
7. Exploitation field boundary
8. Supposed leaching limits of salt series
9. Groundwater flow direction
10. Exploitation wells
11. Groundwater level (GWL)