

Level of Water Content of the Salt Deposits in the Tuzla Basin

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ABSTRACT

Water content of the salt deposits in the Tuzla basin will be summarized in the paper. There will be also given their interdependence in hydrogeologic terms as well as water content modifications during the salt deposit exploitations in Tuzla.

Ground water emergence, types of water, their affects to exploitation in concrete examples, all will be analyzed. In the salt deposit exploitation in Tuzla, ground waters were of great importance, for, the consequences of such an exploitation have been know nowadays to properly qualified personal as well as to other sphere of interest in the country and abroad.

INTRODUCTION

With a long-lasting exploitation of the salt deposits in the Tuzla basin, which is presently the most unacceptable and subeconomic method, the changes of water content deposits have been enabled in time function. A permanent task for the experienced in the Tuzla Salt Mine has been studying these problems either for maintaining the existing production or for purpose of acquiring new scientific knowledge. Ground water plays a significant role as a solvent in exploitation of the salt dissolving the ore. Through the salt dissolution the rock mass deficit has been created and it is filled with the upper wall sediment block caving, all this resulting in the subsidence on the soil surface.

Knowing these problems further investigations have been performed for the purpose of discovering new deposits as the substituting capacities. Thus, the rock salt deposits have been found as Tetima near Gornja Tuzla and at the Lipnica place, northwest from Tuzla. Exploration of the water content level of the new salt deposits enabled us to understand more easily the formation of the natural water content level of the salt deposits in Tuzla.

Water content of the three known salt deposits, then the natural conditions of the water content as well as the artificial conditions of the water content have been considered in this study. Finally, explanation is given to what extent exploitation of the salt deposits influences

26 Djurić - Water Content of Salt Deposits

the condition change of the natural level of the water content depending upon its exploitation method.

SALT DEPOSITS IN THE TUZLA BASIN

Expanding of the salt in Yugoslavia is related to the Tuzla basin, the banded series sediments of Miocene age in geologic terms. So far the known and explored salt deposits have been less in size and as such have not been of great significance on the world wide basis. As Yugoslavia has been known for not having larger salt deposits, and as the interest in this ore is great, these salt deposits have acquired their position in the scope of the mining and industry development.

The entire complex of the banded series sediments, involving several hundred square kilometers, is interesting for the exploration of the salt deposits. Presence of the brine springs on the soil surface is the first indicator for the salt rock presence to a more or less proportion. Consequently, with the brine spring presence in the alluvium of the Solina and Jala rivers, the rock salt deposit was found in Tuzla, which had passed through various stages of exploitation. Size of the deposits being about 2 square kilometers, lenticular in shape, consisting of 5 salt rock series.

Exploitation of the rock salt deposits in Tuzla can be divided into three stages:

- **Natural exploitation of the salt deposits**, as a result of the salt rock dissolution due to the natural flow of the ground waters and their drainage through springs of 63 g/l concentration.
- **Turkish exploitation of the deposits**, having been developed through the dug wells, represents the period between the Turkish settlement in 1482 and the Austro-Hungarians in 1885 to this locality.
- **Uncontrollable brine exploitation** through the dug wells from the soil surface, beginning with Austro-Hungarian settlement and lasts to the present days. It is based on the water handling uncontrollably dissolving the salt rocks, being saturated up to necessary concentration of about 300 g/l, and as such being exploited and transported to the consumers.

As the uncontrollable exploitation of the salt deposits in Tuzla resulted in detrimental consequences in the town itself, the exploitation of the new salt deposits elsewhere has been hastened lately accelerated. Therefore, the "Tetima" rock salt deposit was found the mid part of 1978, northeastwards from Tuzla at the distance of 15 kms. The size of the salt deposit is identical to that one in Tuzla with the only difference that it has a single salt series. This salt deposit is now days being under preparation for the controllable method of exploitation through brine wells from the soil surface what will result in ceasing of the uncontrollable exploitation of the salt deposit in Tuzla. By the end of 1987, the salt deposit in the Lipnica village, northwestwards from Tuzla at the distance of several kilometers was found that was analogous to the salt deposit in Tuzla. Its features with regard to its extension have not been defined yet and it is in the stage of exploration.

Common to all the salt deposits known, apart from aging of their accompanying sediments is their natural water content.

GEOLOGIC-GEOMORPHOLOGIC CHARACTERISTICS

The rock salt deposits are located within the banded series (heaving shale, marly clay, dolomicryte) forming their direct upper wall and footwal (Fig. 1). At the upper wall above the banded series the sediments are of younger Miocene age. The salt deposits having multiple salt series are also the banded series sediments between single series. At the footwall of the salt Series-I there is the volcanic tuff seam, called pelite (quarty-clay-halite tuffite) which represents an indicator for the upper productive part of the banded series, showing the bedded deposits.

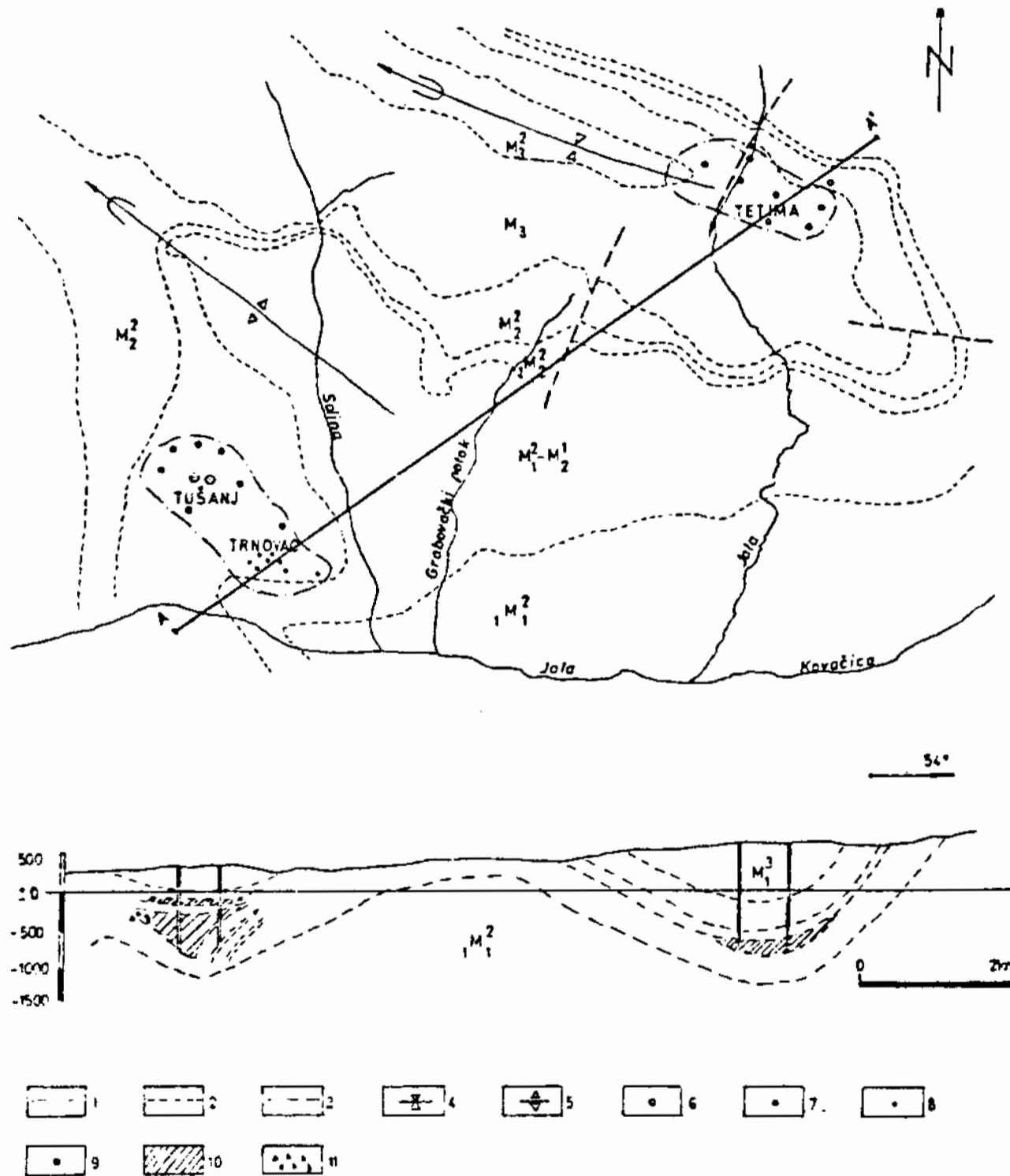


Figure 1. Rock salt deposits in the Tuzla Basin with geologic Profile
(J. Stojković, 1985: N. Đurić, 1991)

- 1. Border of deposits, 2. Border of lithostratigraphic units, 3. Fault Structures,
- 4. Synclinal Axis, 5. Anticline Axis, 6. Exploration Water Wells, 7. Piesometric Water Wells, 8. Exploitation Wells, Conveyance-Outtake Shaft, 10. Salt veins (Salt Series), 11. Anhydrite.

28 Djurić - Water Content of Salt Deposits

The beginning of the geomorphologic surface formation is related to the period of 500,000 years ago. The surface slowly began to alter the then form, rising approximately 1 mm/y. In the later period the surface was obtaining its final form by the tectonic forces existing to the present days.

Natural exploitation of the salt deposits is related to the beginning of the geomorphologic soil forming. Thus, since that period the brine spring presence of various concentrations and water potential has been assumed. Mathematical calculations have the hypothesis that in the period natural exploitation of the salt deposits, one third of today's salt reserves was leached, meaning that the borders of the salt deposits had been significantly larger

WATER CONTENT OF THE SALT DEPOSITS

The salt deposits in Tuzla with regard to the natural water content are of the same characteristics. Thus, at the upper wall of the deposits are ground waters in the cracked (fissured) sediments belonging to the upper torton and sarmate. The water quality is of no great importance and is not in contact with the salt deposits, for, they are separated by the seam of impermeable sediments of the lower torton.

At the limit of the salt deposits, particularly in the shallower parts of the seam in the northeastern area, ground waters contacting the salt rocks are present. The way and speed of the salt rock dissolution depends on the ground water flows as well as their inflow toward the central part of the deposit, along the salt and upper wall sediment contacts, forming fissured-karst water table. The ground waters of this water table are younger by its origin and are similar to the recent ground waters. The type of such water content presently exists at the Tetima and Lipnica rock salt deposits, while the natural level of water content in the Tuzla rock salt deposit has been disturbed.

At the footwall of the salt deposit are so called "sedimentary ground waters" originated from the period of the deposit sedimentation. Their maximum mineralization is over 300 g/l, and represent no larger quantities.

Artificial level of water content is formed owing to changes of the conditions of natural water content as a result of ground water handling. At the salt deposit in Tuzla due to exploitation of the ground waters, the natural level of water content at the upper wall and the limited part of the deposit have been disturbed.

Since the beginning of the Turkish exploitation to the present days, the level of water content has been increased in time function. Initially, water handling of smaller ground water quantities has been done from the dug wells, being increased after a time

and became larger comparing to the natural inflows into the deposit. Thus, isopiestic level was lowered by 20-30 m during the period of 400 years of exploitation.

Applying the method of uncontrollable brine exploitation, significantly larger quantities have been exploited, particularly in the period of the last 30 years. With the increased brine exploitation, the ground water regime has been changing, in other words the isopiestic level was lowering. Maximum rate of the isopiestic level of the ground waters is approximately 200m.

Djurić - Water Content of Salt Deposits

Characteristic of the salt deposits is that during the brine exploitation, the salt rocks are dissolved, resulting in the rock mass deficit. The deficit make up is made by the upper wall sediment block caving, resulting in subsidence on the soil surface. Thus, during the period of 100 years the soil has been subsided for more that 12 m owing to uncontrolable exploitation of the salt deposits in Tuzla. The changes visible on the soil surface are present in the underground as well, particularly in area of exploitation where causes of the rock mass deformations arise.

Disturbing the natural balance the artificial level of water content increases. Thus, ground waters found at the limited part of the surface northeast from the salt deposit had been gradually imerged into the central salt deposit line extending the limits of the fissured-karst water table. The porosity of aquifer is different. Therefore, in the area of exploitation, the salt rock leaching is the largest, resulting in so called the karst porosity. Away from this area, the porosity is lowered, for, consolidation of the previously leached area. Consolidation has been done to that extent that they become water impermeable.

Observed on the whole it can be said that the artificial water content has been present from they very beginning of the natural balance disturbane and that it is changed in the function of the brine exploitation. The more increased the brine exploitation the more increased the level of water content salt deposit, but that rising is not constant, because a part of previously leached zones is being consolidated what lessen the water content zone.

Exploitation of the brine has been lessen lately and for this reason the surface subsidence has been slowed down and the isopiestic level has been raised. Consolidation of the leached zones has been fastened and as for the limits of the fissured-karst water table, in other words the artificial level of water content, they have been lowered.

In the forthcoming period the cease of the exploitation of the brine is anticipated where the ground water regime will tend to have the form nearly analogous tot hat one before the beginning of the artificial disturbance. The leached zones will be consolidated to that extent that they will become watertight and the ground water flow will be performed along the active leachings, namely, in the contact with the salt rocks. The previously formed limits of the fissured-karst water table, as the result of the increased artificial level of water content, will be gradually lowered and have the form of the limits corresponding to the conditions of the natural level of water content.

Closing this chapter it should be pointed out that the artificial water content increase of the salt deposits in Tuzla had no impact on the two other salt deposits in the change of natural balance.

CONCLUSION

The salt deposits in the Tuzla basin have been related to the banded series sediments of Miocene age. Such three salt deposits have been known to the present day. The existing salt deposit in Tuzla has been exploiting for more than 500 years, of which the last 100 years more intensively, applying the method of the uncontrollable exploitation of the brine through the brine wells from the surface. The other two salt deposits in the Tetima and Lipnica area have been found later. The Tetima salt deposits has been explored and it is the stage of preparation for exploiting, while the Lipnica salt deposit is beginning in the exploratory stage.

30 Djurić - Water Content of Salt Deposits

balance conditions. So, at the Tuzla salt deposit in the past period of the exploitation natural conditions of water content have been changed and artificial conditions of the water content dominate. During that period the initial view, hydrogeologic view has obtained another appearance, for, new hydrogeologic conditions have been created, dictated by exploitation of the brine.

Change of the water content conditions at the salt deposit had no impact on the other two deposits where continuation of the natural conditions of water content persist.

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