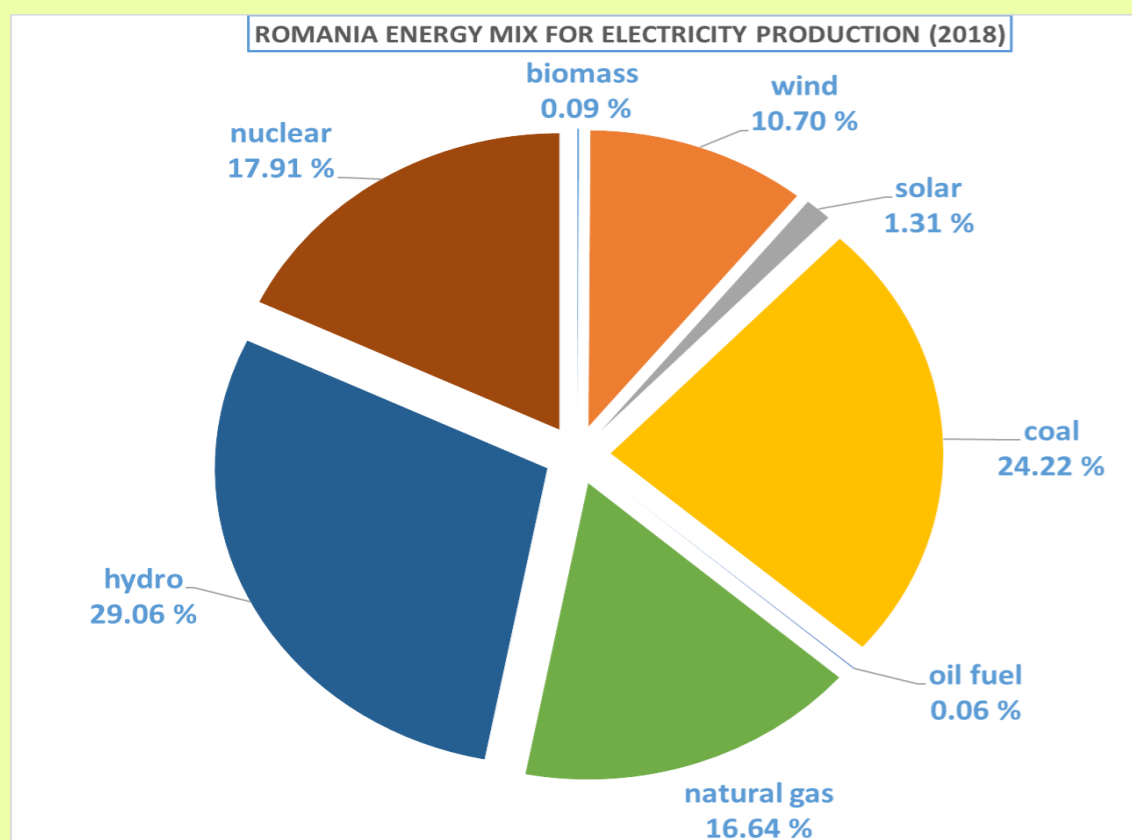# PRELIMINARY EVALUATION ON GEOLOGICAL ENERGY STORAGE SOLUTIONS IN ROMANIA

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## Electricity production in Romania



On the national level, Romania is committed to decrease the greenhouse gas emissions and to increase the share of renewables in the energy mix while increasing energy security and stability. In the recent years, the share of renewables in the energy mix continuously increased, reaching in 2018 at 10.7 % of wind energy and 1.31 % of solar energy (ANRE, 2018). Taking into account this situation, the need of energy storage has become widely recognized. As for geological energy storage, Romania has the experience of storing for decades natural gas.
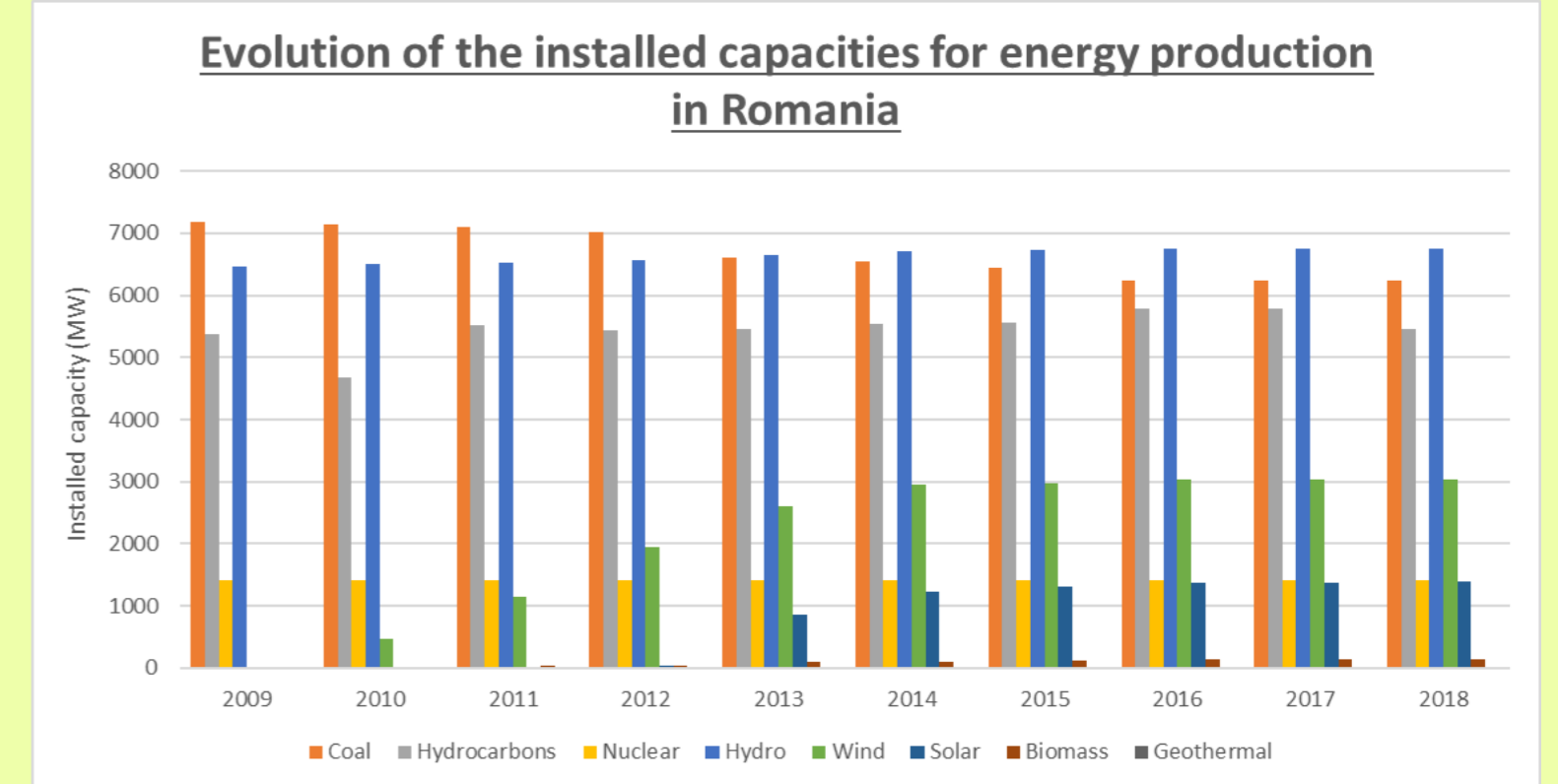


Modified after ANRE, 2019. National report for 2018

## Hydrogen and compressed air storage possibilities in Romania
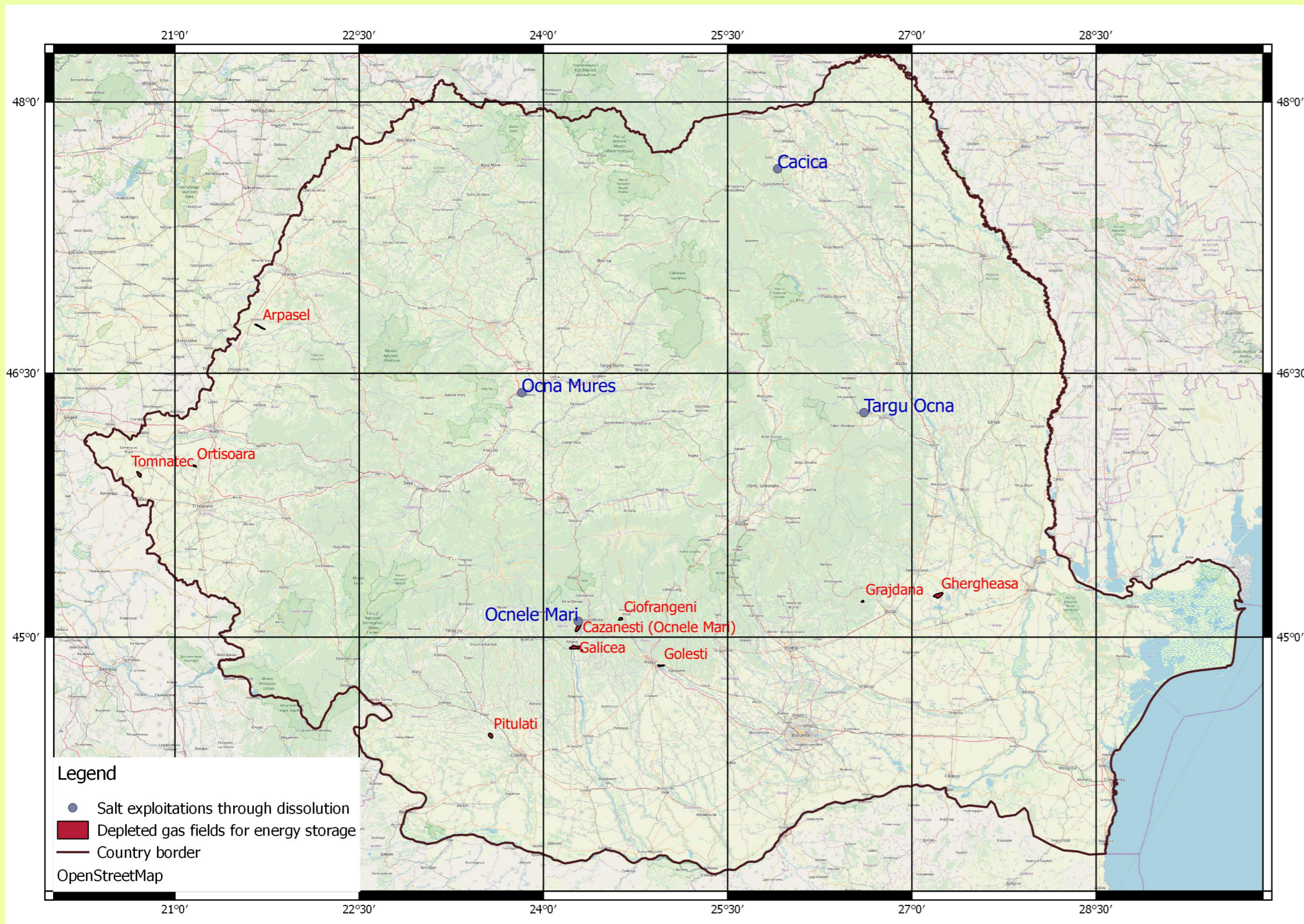


In this context of increase in share of renewables to the national power grid and the large installed capacity of these sources, there is clearly a need for energy storage. In 2016, a primary evaluation of potential for geological energy storage has been made by GeoEcoMar, in the frame of a national research project. The study focused mostly on identification of solutions for hydrogen and compressed air energy storage.

For hydrogen storage, we identified ten depleted and abandoned gas fields, which are not used or planned to be used in the near future for seasonal natural gas storage. These fields are: Căzăneşti (Ocnele Mari), Galicea, Ciofrângeni and Goleşti in Getic Depression ; Ghergheasa and Pitulati in Moesian Platform; Grăjdana in Mio-Pliocene Zone; Tomnatec , Ortişoara and Arpăşel in Pannonian Depression. The total volumetric capacity of hydrogen storage in the identified depleted gas fields is 2762 billion m$^3$, with an energy capacity of 5316.95 GW.

For compressed air energy storage, we considered, based on literature review, that the best solution is represented by salt caverns obtained from the exploitation of salt by dissolution (dissolution). For our country, although there are numerous salt deposits in the sedimentation basins, and evidence of salt exploitation dates back to ancient times, the technology of salt exploitation by dissolution was less used than the exploitation with galleries. Still, salt exploitation through dissolution is implemented at four salt exploitations, Ocna Mures, Ocnele Mari, Targu Ocna and Cacica. Therefore the estimation of the storage capacity in salt caverns was made taking into account the exploitation of these deposits and the estimated volume of salt caverns formed there. The compressed air storage capacity in the aforementioned deposits was estimated at 4287 billion m$^3$, and the energy capacity at 1811.04 GW.

## Geophysical investigation of Targu Ocna salt exploitation

Taking into account the problems reported in the last two decades with ground subsidence and brine infiltration in the salt dissolution exploitation areas from Romania, we have set de objective to investigate the stability of selected salt caverns using geophysical methods (gravity and electric measurements).

We have to mention that the caverns to be investigated were selected in an area where fewer problems were reported.

The selected investigation zone is located in the north area of the salt body from Targu Ocna used for the salt exploitation through wells using dissolution. There are nine exploitation wells within the perimeter, but, after discussions with the field operator, we have decided to focus on the area of three wells named 259, 251 and 253 where could exist a near surface channel through which the brine is flowing towards the north area where a brine lake was formed.

In order to be able to detect the supposed channel, a brief modelling of the gravity effects of the dissolution caverns was made and the results were used to design the gravity survey and the location of the electric measurements profiles (Vertical Electric Sounding – VES). The gravity stations were spaced at 25 m in order to cover homogeneously the investigated area. The electric measurements (VES) were made on a line transverse to the direction of the supposed channel.

Gravity was measured on 101 stations using CG5 Autograv relative gravimeter from Scintrex. The standard resolution is 1 µGal. The gravity values were transmitted from the closest station of the national gravity network to the work perimeter where two gravity local bases were determined. From these local bases four measurement cycles were made.
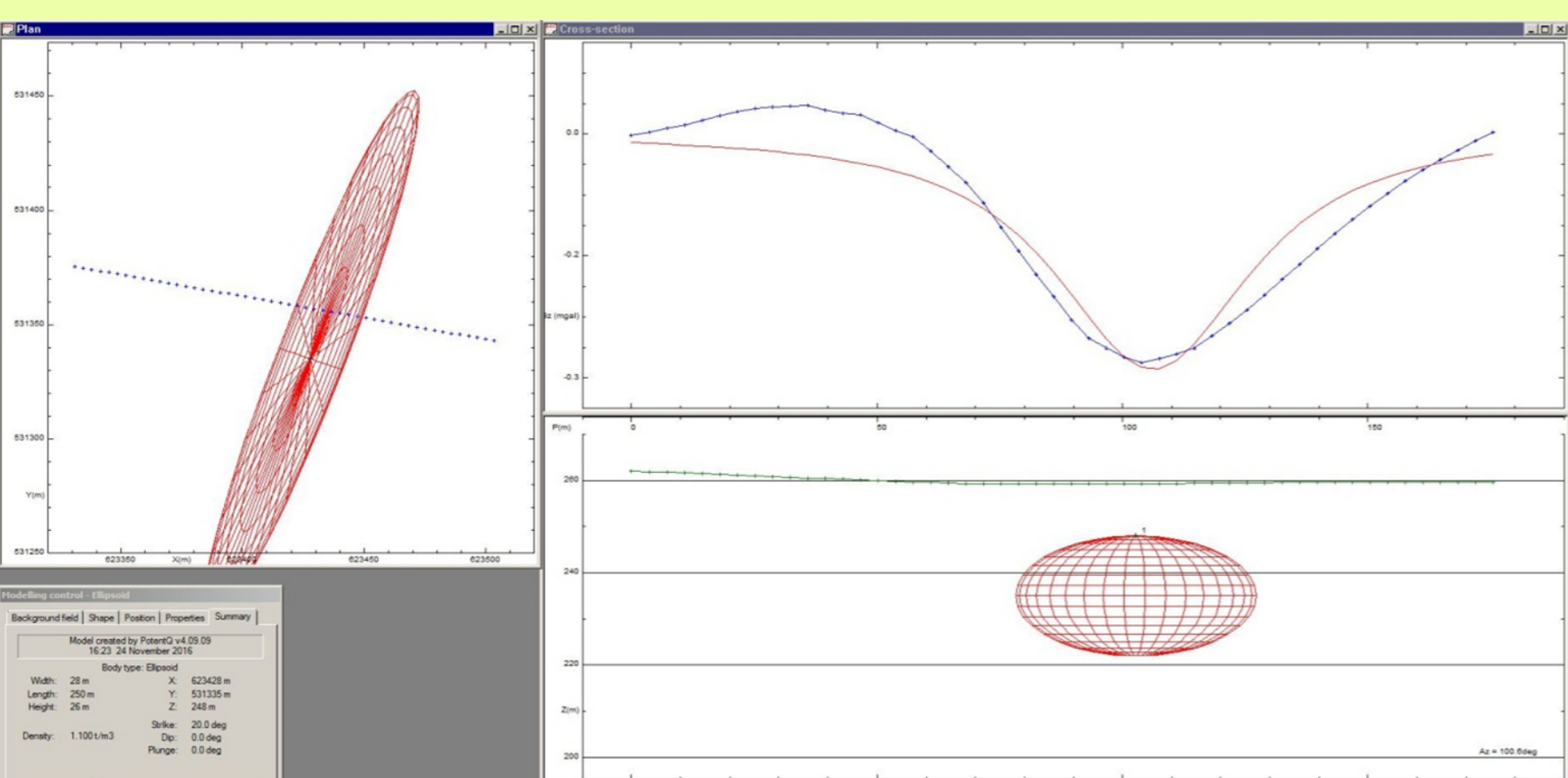
The electric measurements were conducted using a rezistivimeter and a Schlumberger array on four VES lines spaced at 10 m, with the measuring electrodes spaced at 2 m and the injection electrodes positioned at 4, 10, 30, 70, 91, 110 and 130 m.

Gravity anomaly was calculated for a density of the environment of 2.2 g/cm3. The obtained values were interpolated at 0.01 mGals.As it can be seen from the gravity map, within the perimeter of the wells 259, 251 and 253, there is a minimum gravity anomaly of 0.3 mGals, extending on a NE-SW direction that could be the effect of a channel of brine circulation between wells and dissolution caverns.

The apparent resistivity section indicates a decrease of resistivity near ground surface that could also be an effect of brine accumulation.
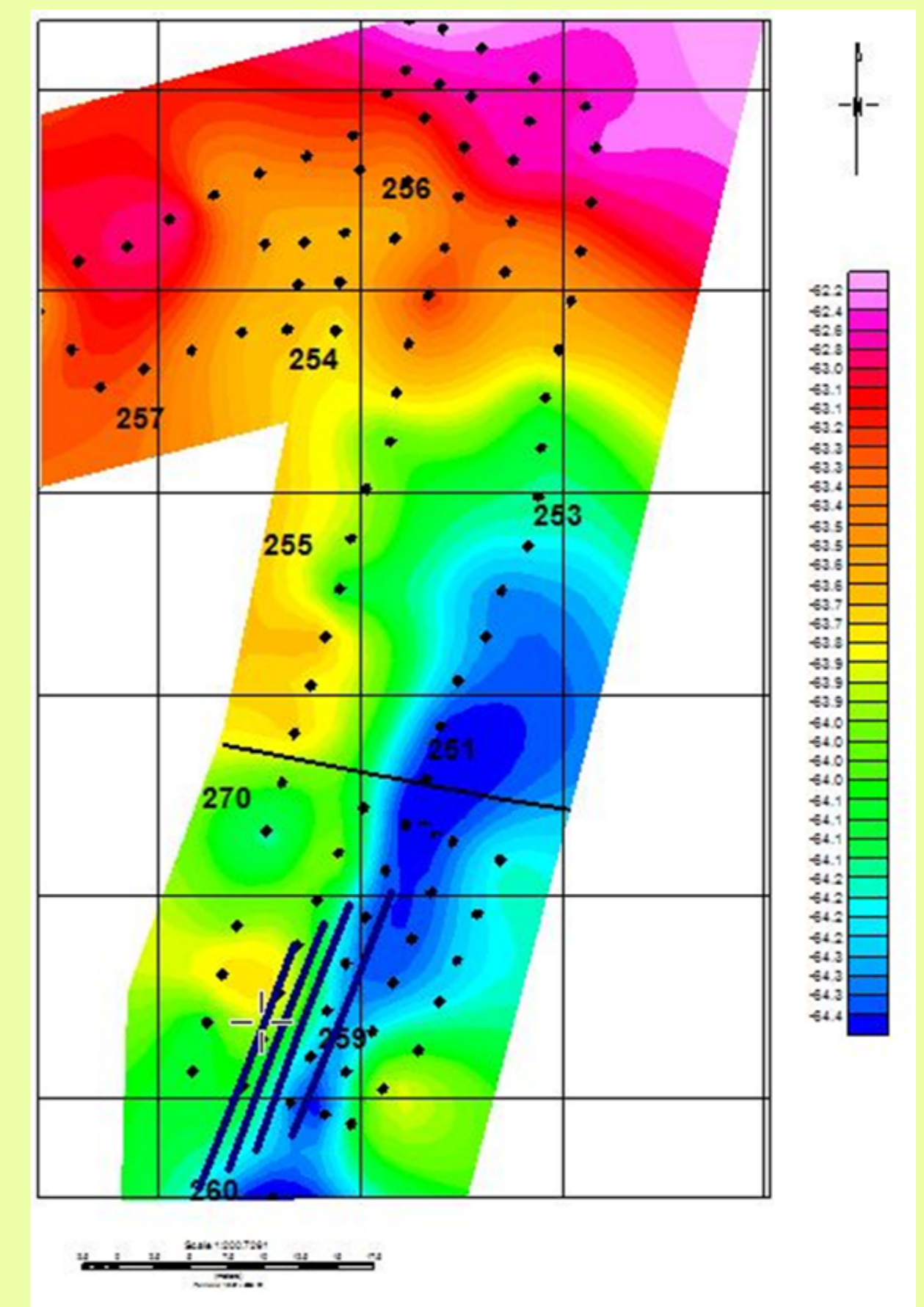
## 2D modeling and conclusions of the geophysical investigation

In order to analyse the minimum gravity anomaly obtained on the gravity anomaly map, we have made a 2D modelling using Potent Q modelling extension of Oasis Montaj software on a profile with WE orientation. The result, illustrated through Figure 3, was that the minimum gravity effect could be due to the presence of an ellipsoidal body with the centre at approximately 30 m below ground surface, south from 251 exploitation well, 28 m width, 250 m length, 26 m height and with a density of 1.1 g/cm3. The density used for modelling corresponds to a body filled with brine.



Gravity anomaly map (blue lines - VES profiles, AA' - modeling profile,   black points - gravity stations, exploitation wells - numbers)
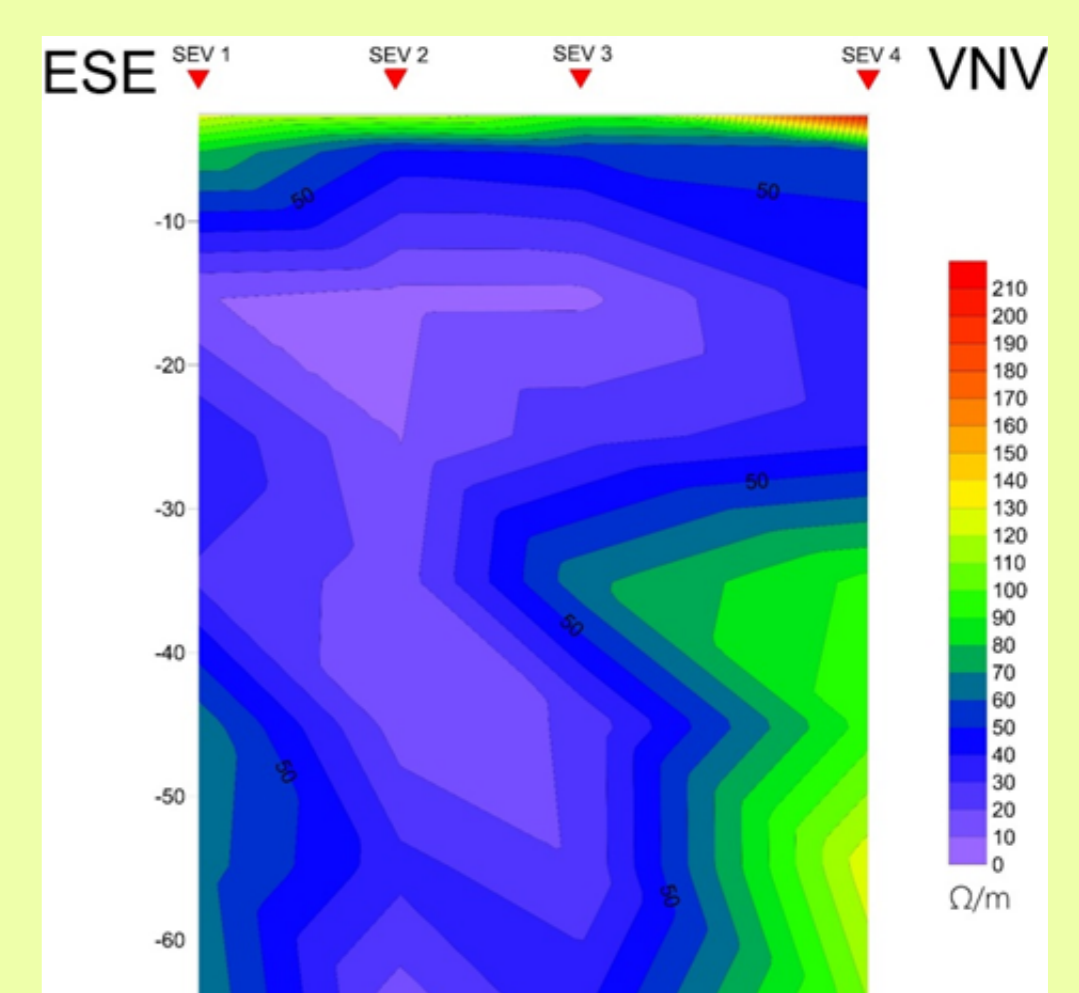


2 D modelling

The results of the gravity survey and modelling and the results of the electric survey indicate that it is very likely that in the investigated area a channel through which brine circulates was formed, most probably as a result of salt exploitation through wells. The most probable implication is the area is not suited for geological energy storage due to instability issues. Nevertheless, our results should be further investigated in order to effectively prove the existence of the channel and to be able to design solutions for increasing stability of the caverns, establish dissolution control and prevent ground sinking and cavern collapsing.

Aparent rezistivity profile