DEPROIL
DETAILED OIL & GAS PROSPECTING

85% -
SUCCESS RATE
25 fields
81 wells
166 well tests

- High precision gravity observations
- 3D model of density of the artificial gas reservoirs
- Location and shape of the artificial gas reservoirs
- Current gas saturation within the artificial reservoir
- Gas reserves within the artificial reservoir

ARTIFICIAL GAS RESERVOIRS MAPPING

OVER TWO DECADES OF RELIABLE HYDROCARBON-BEARING RESERVOIR EXPLORATION

MAPPING THE LOCATION OF LOST GAS IN OLYSHIV UNDERGROUND STORAGE BASED ON THE HIGH-PRECISION GRAVIMETRIC OBSERVATIONS

Olyshivka underground gas storage (UGS), the northwestern part of the Dnieper-Donets Depression, Ukraine, 2017.

GEOLOGICAL PROBLEM

Olyshivka UGS was created in a natural aquifer of Bathonian and Bajocian of the middle Jurassic in 1982. UGS has a water drive regime of exploitation. Geological structure extended brachianticline with sizes 6,7 x 3,6 km. Reservoir depth - 550-565 m. below ground level. UGS area - 32,9 km^2. UGS reservoir is composed of brittle sandstone and fine sand. Average reservoir porosity 33-36 %. Project storage pressure range - 35-71 kgf/cm^2. Total project gas volume 660 Mcm, the project working gas volume is 310 Mcm. Since 2011 UGS had been exploited only for withdrawing. Withdrawing is accompanied by a lot amount of sand recovery, which occurs storage wells failure because of sand filter congestion. Gradual increasing of water influx in storage wells had been observed during gas withdrawal. This situation is probably caused by project exploitation regime disturbance in previous years. 356,5 Mcm of gas contained in UGS at the moment of gravity acquisition as spring 2016. Average storage pressure in storage wells 51.8 kgf/cm^2. Most storage wells need to be repaired because of sand corks and inflow of water. As of 2016 only 2 of 32 storage wells were used for withdrawing. Gravity exploration was used for well water inflow reason determination because gravity exploration gives an opportunity to separate gas saturated and water saturated rocks.

3D GTAVITY INVERSION WORKFLOW

High precision gravity measurements were taken within an area 120 km^2 by 100 x 100 meters gravity stations network. Standard deviation (SD) of complete Bougue determination was 7,3 mkGal. It is more than twice lower than the theoretically calculated gravity effect from the artificial reservoir of Olyshivka UGS 14 - 44 mkGal. The 3D density model of Olyshivka UGS was created on the next stage of exploration. The structural framework of the 3D model consists of 24 surfaces and was built using 2D seismic and well tops data. Well logging was used for density and porosity estimation. 3D density model consists of 65,1 millions cells with planar dimensions 100 x 100 meters and vertical size 2,5 meters. Planar 3D model dimensions are 17,5 x 9,2 km. The depth interval of the 3D model is from 0 to 10,1 km. The standard deviation between observed and calculated gravity fields for the initial 3D density model was 7,2 mGal. 3D density model was refined by a joint full-depth 3D linear inversion of the surface gravity field and well data. The standard deviation between observed and calculated gravity fields for the final 3D density model was 0,044 mGal (Figure 1). Regarding the gravity field, the initial 3D density model was improved 164 times. Two low-density zones related to artificial gas saturated reservoirs were mapped as a result of obtained 3D model analysis (Figure 2). 3D model of current gas saturation of Olyshivka UGS was calculated using the obtained 3D model, core results analysis, and known petrophysical dependencies (Figure 3). Prospective gas volume was calculated within two mapped artificial reservoirs. Results of Monte Carlo modeling were used as independent gas volume rating within these reservoirs (Figure 4). Taking into account the executed calculation there is 82.4 % of UGS balance gas volume with 50 % probability P50 is located within two new mapped artificial reservoirs.

GEOLOGICAL RESULTS

Provided exploration ensured the mapping of two new separate artificial reservoirs. Part of the gas of the main Olyshivka UGS reservoir flowed to mapped reservoirs. 3D model of current reservoir gas saturation was created and the gas volume of mapped reservoirs was calculated. Storage well within north mapped reservoirs was proposed to be overhaul for remaining cushion gas production. In addition, three new wells proposed to be drilled.

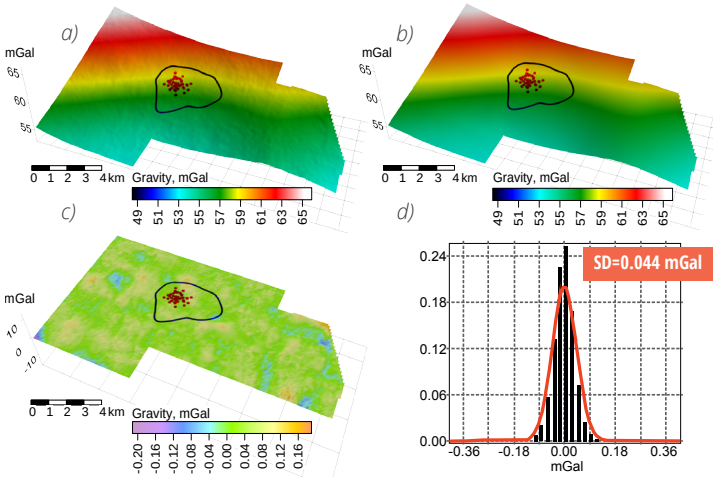

Figure 1. Observed (a) and calculated from the final 3D density model (b) gravity fields, a deviation between gravity fields (c) and distribution of deviation histogram (d)

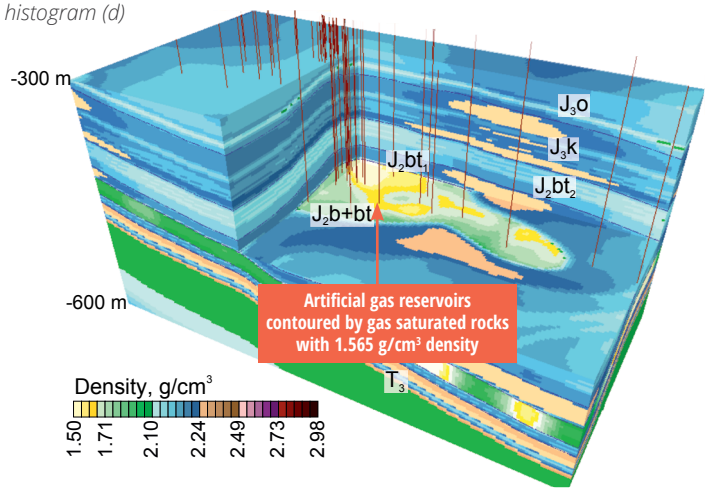

Figure 2. Artificial gas reservoirs in the 3D density model of Olyshivka UGS as a 3D objects with density rate of >1.565 g/ccm

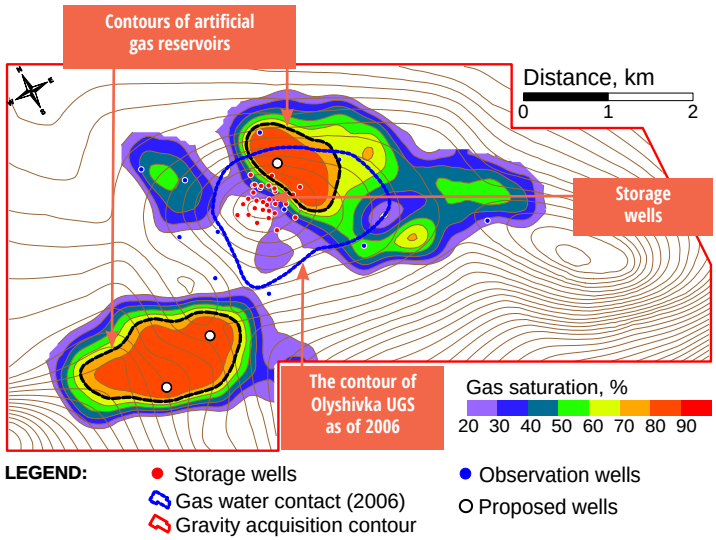

Figure 3. Gas saturation of Bathonian and Bajocian sandstones of Olyshivka UGS. Contours of artificial gas reservoirs determined by critical gas saturation of 70 % as of 2017

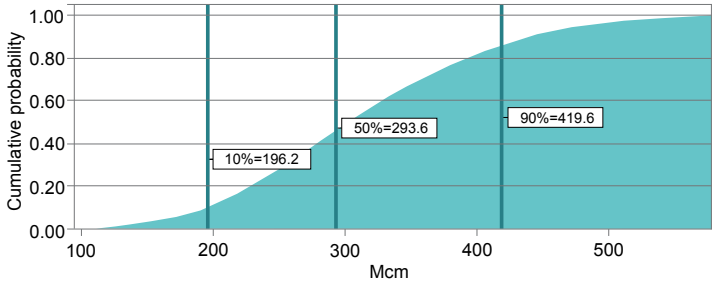

Figure 4. Gas resources within artificial reservoirs by the results of Monte Carlo modeling