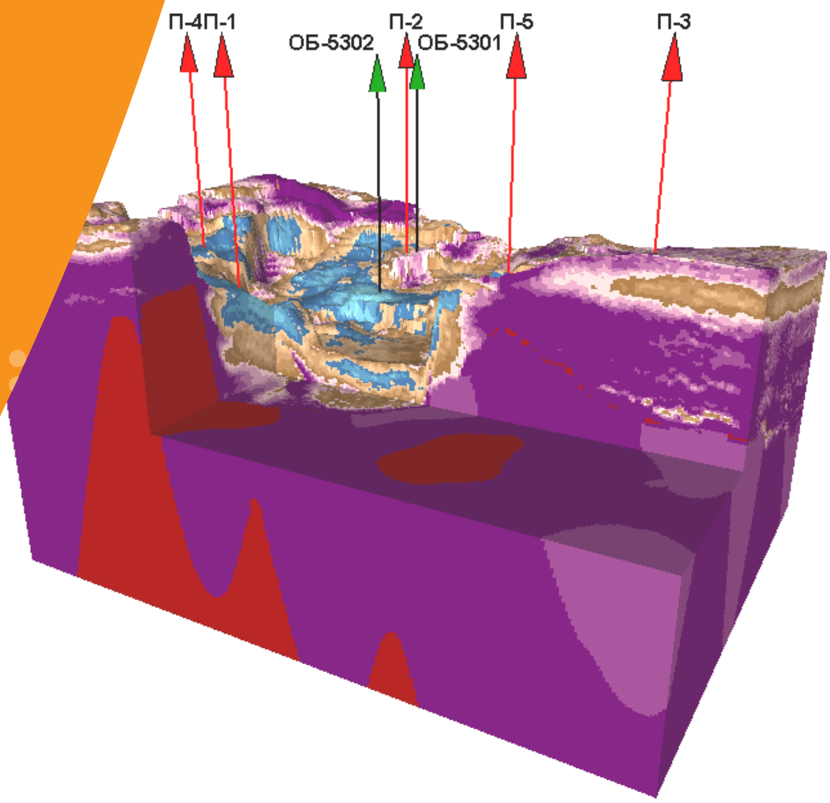
DEPROIL

DETAILED OIL & GAS PROSPECTING

- High-precision 3D gravimetric survey
- Full 3D density model of the astrobleme
- Mapping of commercial hydrocarbon pools
- Ranking of commercial pools by multiple geophysical and geochemical parameters



OBOLON ASTROBLEME UNCONVENTIONAL HYDROCARBON POOLS

OBOLON ASTROBLEME
UNCONVENTIONAL OIL AND GAS RESERVOIRS

Southern Margin of Dnieper-Donets Depression,
Ukraine, 2011

GEOLOGICAL PROBLEM

In recent years, in Dnieper-Donets depression there is a tendency of decreasing sizes and number of anticlinal oil and gas traps prepared for deep drilling. To increase hydrocarbon potential in Ukraine, it is necessary to explore not only for anticlines but also for all other potential types of hydrocarbon-bearing reservoirs. Basing on world experience, astroblemes which are meteorite-impact structures, should be considered as one of the new types of oil and gas bearing objects. Commercial oil and gas production is proven today in ten out of twenty astroblemes in North America. According to the "Earth Impakt Database", Obolon astrobleme is a large circular depression almost 20 km in diameter. Two exploration wells #5301 and #5302 were drilled within the central part of the depression in 1965-1966 after regional exploration activities. The drilling results showed no signs of hydrocarbon presence and oil shales in particular. However, taking into account the large size of the depression and theoretically predicted hydrocarbon resources, in 2010-2011 an additional detailed geological and geophysical surveys were conducted, including 3D seismic survey (1:25 000), high-precision gravimetric and magnetometric survey (1:10 000), as well as regional geochemical observations (1:200 000).

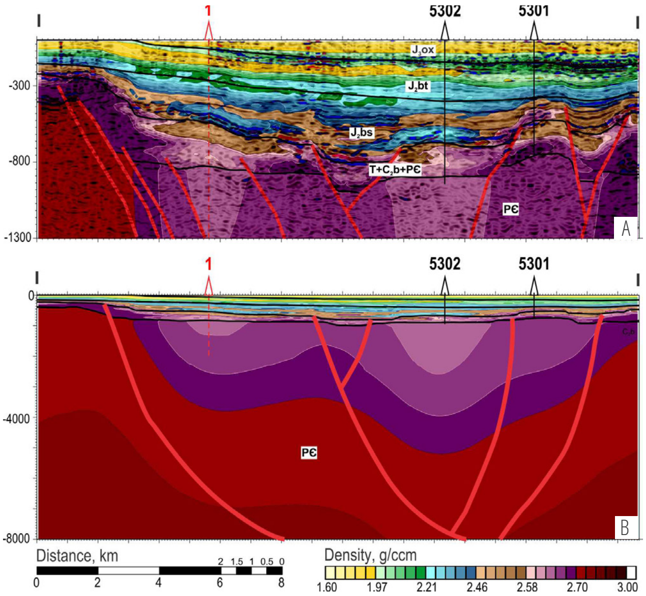


Figure 1. Rock density distribution within the sedimentary cover (A) and crystaline basement (B). Section line crosses the firs priority prospect and the recommended well #1

3D GRAVITY INVERSION WORKFLOW

Structural framework for the initial 3D density model of Obolon astrobleme was built using the results of 3D seismic survey - structural maps of five reflecting horizons in Jurassic (IIб, IIв$_1$, IIв$_2$), Carboniferous (Vb) and upper part of the crystalline basement (VII). Basing on the dependence of rock's density on its porosity, 3D density model of the sedimentary cover was calculated from the 3D cube of porosity by seismic data. In addition, to construct 3D density model with 5 m vertical resolution, well log data from boreholes #5301 and #5302 within Obolon area were used, as well as core data interpretation from borehole #232 of the neighboring field. The constructed 3D density model's dimensions were 2 km x 2 km laterally and 8 km vertically. The individual cell size of 100 m x 100 m x 5 m resulted in the total of over 6 878 480 cells.

To refine the parameters of 3D property model of Obolon area, 3D joint linear inversion of gravity, well logging and seismic data was performed. Standard deviation between the observed gravity and gravity calculated from the initial 3D density model was 3.61 mGal; between observed gravity and gravity calculated from the resulting 3D density model was 0.066 mGal. Relative to the gravity field, the initial 3D density model was improved by 55 times.

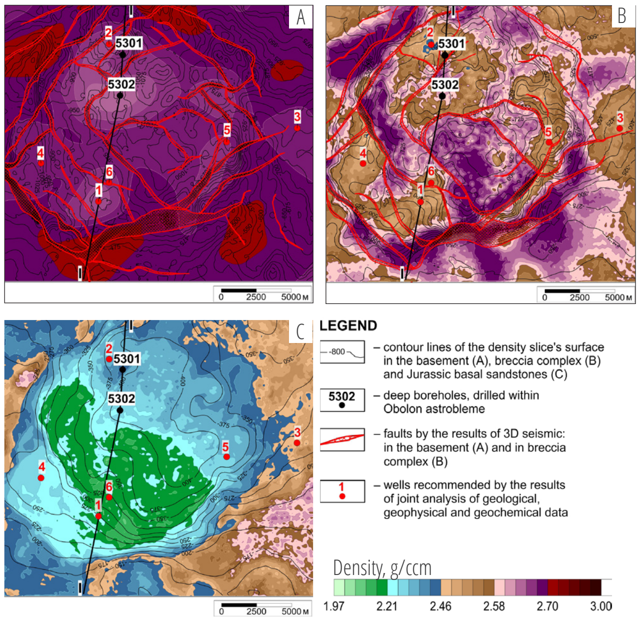


Figure 2. Spatial distribution of rock density in the upper part of the basement (A), breccia complex (B) and Jurassic basal sandstones of an overlaying complex (C)

GEOLOGICAL RESULTS

Overall seven prospects associated with low-density anomalies have been mapped within Obolon astrobleme (fig. 2). All of them were ranked by priority into three groups - perspective, high-promising and first priority (fig. 3). To estimate the priority of new prospects and to select the top priority one for exploration drilling additional data of magnetic, geochemical, and thermometric surveys were involved into study. The last ones were used as indicators of integrity/tectonic fragmentation of predicted hydrocarbon-bearing reservoirs and as indicators of areas with potential deposit destruction, characterized by higher activities of hydrocarbon migration.

The first priority prospect for exploration drilling is the object around recommended well #1 (fig 1, 2, 3). The prospect is presented by a tectonically screened block within the crater rim in the South-Western part of the structure. Perspective hydrocarbon reservoirs were mapped within the upper part of the crystalline basement, breccia complex and Jurassic basal sandstones of overlaying complex. Other six prospects were recommended for further drilling, including one deep target in the crystalline basement within the North-Western close to the central part of the structure and also several prospects within and outside the rim and breccia rocks.

The potential hydrocarbon reserves of new prospects were estimated by means of the volumetric Monte Carlo method. New prospects were ranged by the value of predicted pore space volume within the entire geological section, as well as for each lithological / stratigraphical unit. By the value of predicted pore space volume, the most promising sediments belong to breccia complex - 2.08 km^3, less promising are Jurassic basal sandstones - 0.87 km^3 and basement rocks - 0.14 km^3. It should be noted, that the most promising reservoirs of the basement are concentrated in the central part of the astrobleme, while in a sedimentary cover new prospects are localized outside of the astrobleme's crater.

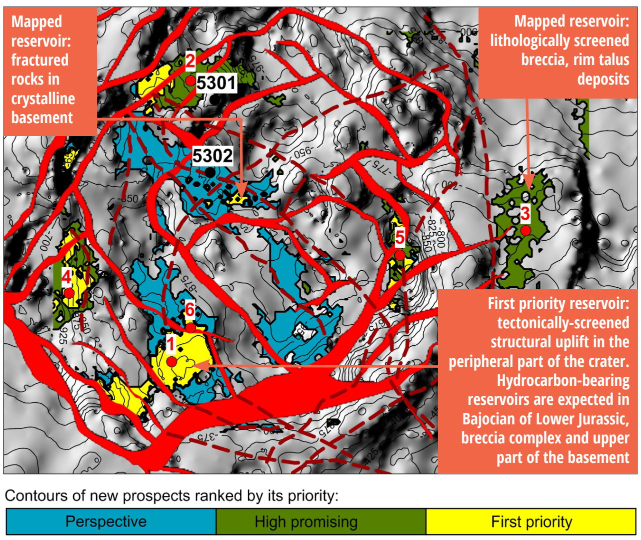


Figure 3. Localization of new hydrocarbon-bearing reservoirs within Obolon astrobleme, ranked by the results of joint analysis of geophysical and geochemical data