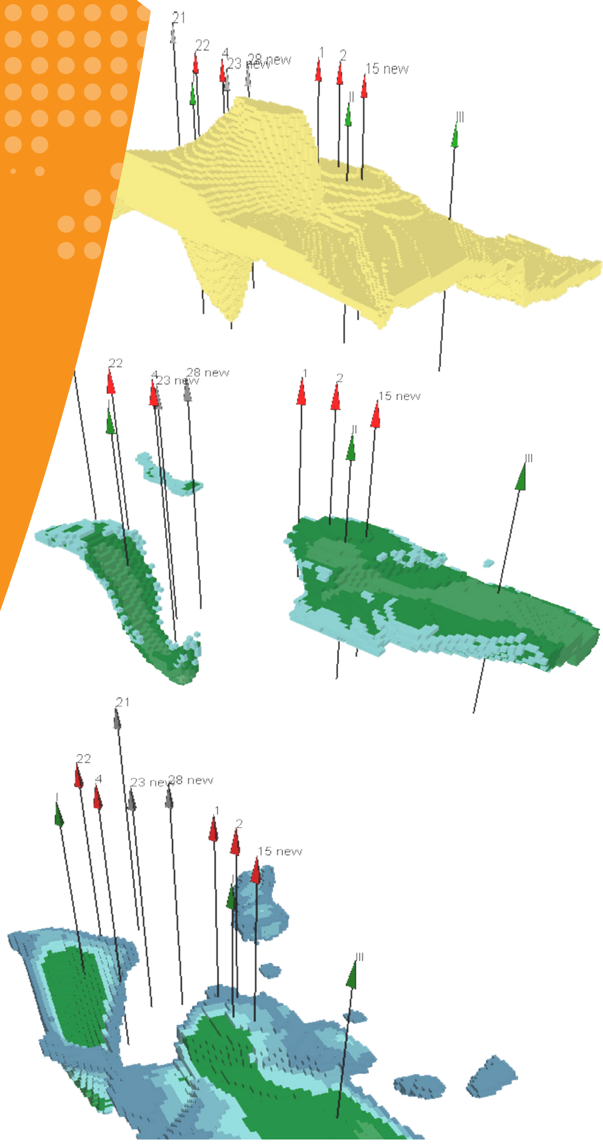
DEPROIL

DETAILED OIL & GAS PROSPECTING



THE ACCURATE SHAPE OF SALT DIAPIR AND NEAR-SALT COMMERCIAL HYDROCARBON POOLS AS A RESULT OF A 3D JOINT GRAVITY, WELL-LOG, AND SEISMIC INVERSION

30+ YEARS OF EXPERIENCE IN MAPPING COMMERCIAL HYDROCARBON POOLS

ACCURATE MAPPING OF THE BUDYSCHANY SALT DIAPIR REVEALS TWO NEW COMMERCIAL NEAR-SALT HYDROCARBON POOLS WITHIN THE "SALT" AREA BY SEISMIC

Dnipro-Donets basin, Ukraine, 2012

STUDY OBJECTIVES

The central part of the Dnipro-Donets Basin is characterized by active salt tectonics. Hydrocarbon accumulations are confined to Carboniferous sediments, which are pierced by Devonian salt. Within the investigated area the Budyshchany salt dome is located. Due to the absence of seismic reflections in the proximity of the salt dome there was ambiguity in the position of the salt wall. High-precision gravity data were used to refine the salt wall position and to determine the location and shape of the commercial hydrocarbon pools.

3D MODELLING WORKFLOW

The 3D structural model consisted of 17 structural surfaces. The latter were built based on 3D seismic data in the target formations in Carboniferous, with consideration for well tops from the neighbouring Matviivka gas field. The top of Devonian mother-salt and basement were built based on the regional 2D seismic data. The density of the initial 3D model of the target Carboniferous interval was defined using sonic logs from the wells of the neighboring Matviivka field. For the rest of the sequence, regional dependencies of density from age, lithology, and depth were used.

The shape of the salt diapir and the thickness of mother-salt were refined with a 3D structural inverse problem. A heterogeneous 3D density distribution was refined for the entire section from the day surface down to the basement with a 3D linear inverse problem. The model consisted of 11.2 mln. cells. The cell size was 100x100x50 m.

The root mean square deviation between the measured and modelled gravity for the initial 3D model was 4.639 mGal (Figure III-1e), while for the final 3D model it was 0.048 mGal (Figure III-1f). Relative to the gravity field, the final 3D model was 97 times more accurate than the initial one.

GEOLOGICAL RESULTS

Density distribution of the 3D model evidence that the size of the salt diapir by 3D seismic (Figure III-2a) three times exceeds that by gravimetric data (Figure III-2b). A large area inter preted as salt by seismic data is represented by clastic rocks with localized low-density areas corresponding to reservoir rocks. Cut-off density values of reservoir rocks are 2.37 and 2.5 g/ccm. These areas are located adjacent to the modified salt wall and correspond to expected commercial gas pools (Figure III-3).

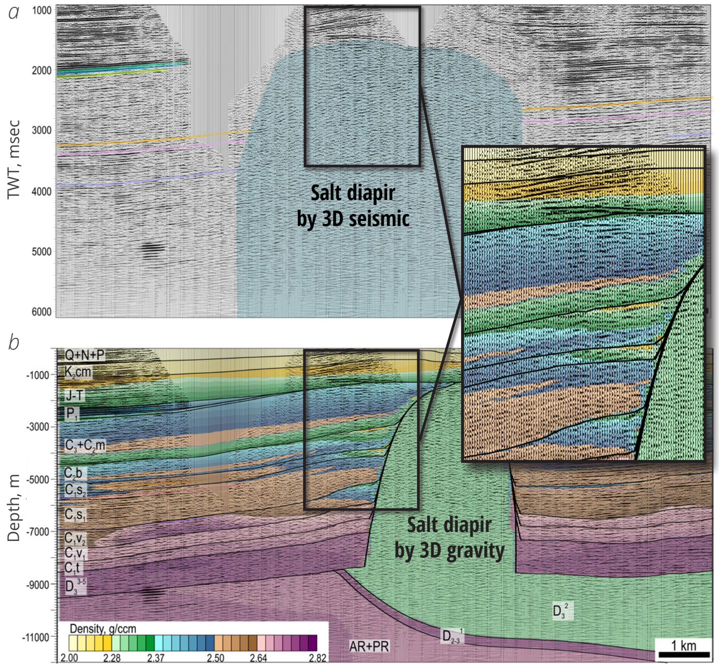


Figure III-2. Salt diapir on the seismic cross-section (a) and superimposed image of seismic and density cross-sections (b). Commercial gas pools are outlined by a cut-off rock density of 2.38–2.37 g/ccm in Upper Visean, Serpukhovian, and Bashkirian formations beside the wall of the salt diapir. The location of the cross-section line is shown on Figure III-3.

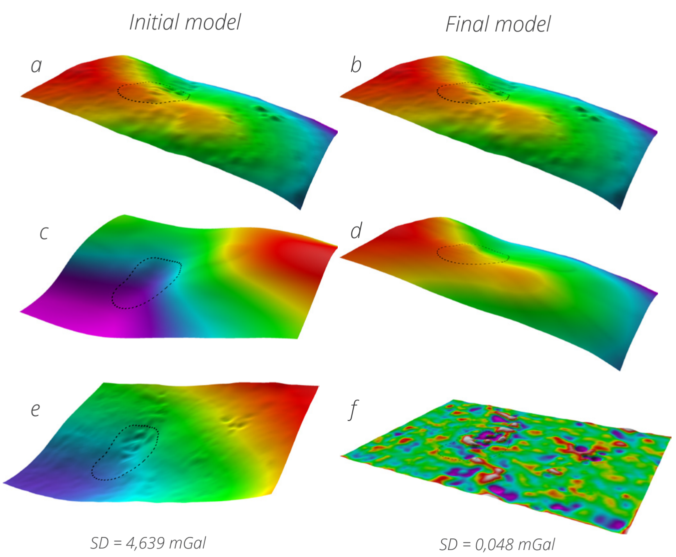


Figure III-1. Measured (a, b) and calculated (c, d) gravity fields for the initial and final 3D density models, and misfits (e, f) respectively

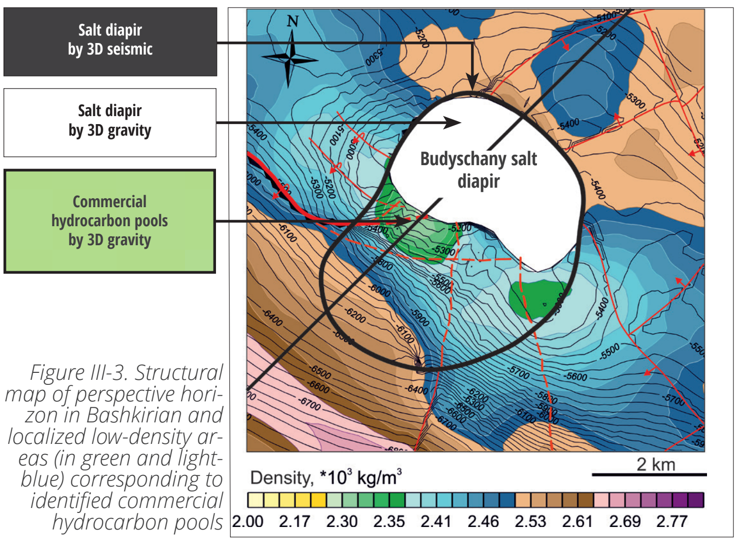


Figure III-3. Structural map of perspective horizon in Bashkirian and localized low-density areas (in green and light-blue) corresponding to identified commercial hydrocarbon pools

SUCCESS FACTORS FOR MAPPING THE COMMERCIAL HYDROCARBON POOLS WITH GRAVITY, WELL LOG, AND SEISMIC DATA

- 3D joint inversion of gravity, well log, seismic, petrophysical, and geological information ensures selection of a single geologically meaningful 3D model from a set of possible models that corresponds to the observed gravity field.
- Geologically meaningful constraints for the model's parameters: rock density, depth of geological boundaries.
- 3D density model covering the entire geological section from the day surface down to the basement or mantle for a case of regional studies.
- Using the complete Bouguer anomaly, without field separation into anomalies associated with target objects. Compensation of the gravity misfit by transformation of the entire density model.
- The use of actual rock density enables the conversion to 3D models of petrophysical parameters, including porosity, hydrocarbon saturation, density of hydrocarbon reserves (which represents the amount of hydrocarbons per rock unit), recoverable and drained reserves, as well as the initial flow rate of new wells.