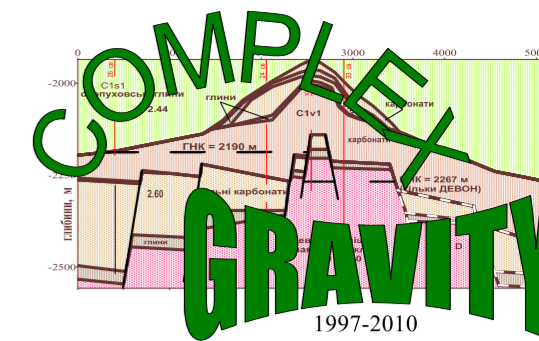


Experience of the 3D interpretation of gravity data in the southeast of Volyno-Podillya

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Introduction

The south-eastern part of Volyno-Podillya is considered to be of little promise. In the platform's sedimentary rock no single oil and gas field has been identified. However, the certain prospects are related to the structural forms of the erosion relief of the surface of the Cambrian complex of rock and in the rocks of the crystalline basement. According to the seismic data was traced the Mesozoic and Paleozoic surfaces, tectonic disturbances have been detected and several prospective objects have been highlighted.

Figures 1, 2 show anomalous gravitational and magnetic fields, as well as promising structures. They are identified with the Ordovician sediments, which filling the depression area of the Cambrian relief; their thickness is up to 200 m (Kh.B. Zayats).

Within the territory, the surface of the Cambrian sediments lies in depth from 300-500 m in the northeast to 2500-3000 m in the southwest from t. Davideny. The uneven of the Cambrian paleorelief, its paleo-noses and the depths of erosive valleys (paleovalleys that are probably filled with the Ordovician terrigenous deposits) grow from the northeast to the south from 30-50 to 200-250 m. The Ordovician terrigenous objects predicted by Kh. B. Zayats are grouped in the plan into the strips of the north-western extend, except for the site that is in the east from t. Storozhinets. They are related to the upthrow-thrusts, caused by the lowering of the blocks of the crystalline basement along the faults. The direction of the strips coincides with the strike of depth tectonic faults, and, therefore, with trend of anomalous zones of gravity-magnetic fields (Fig. 2). The buried tectonic zone identified by Kh. B. Zayats in the basement of the marginal slope of the platform, is complicated by faults and intrusions, especially in the south-western part of the study area. Here this zone influenced to a greater extent the weakening of the integrity of the crustal rocks and probably contributed to the migration of hydrocarbons. These extend zones were the reason for the formation of the prospective structural forms in the Paleozoic and Mesozoic rocks. However, these deposits of the Volyno-Podillya plate and the platform's base of the Pre-Carpathian trough in the southeast have been underexplored due to the small scope of performed seismic studies and the small number of wells that would strip the entire section to the basement.

The extend weakened zones, as well as the lowerings of the basement surface, are reflected in the gravity and magnetic fields by bands of negative anomalies (Fig. 2). Therefore, the usage of gravity and magnetic data to track these zones, faults, as well as highlighting the upstanding or downthrown basement blocks will increase the reliability of assessing the prospects of oil-and-gas content in this area.

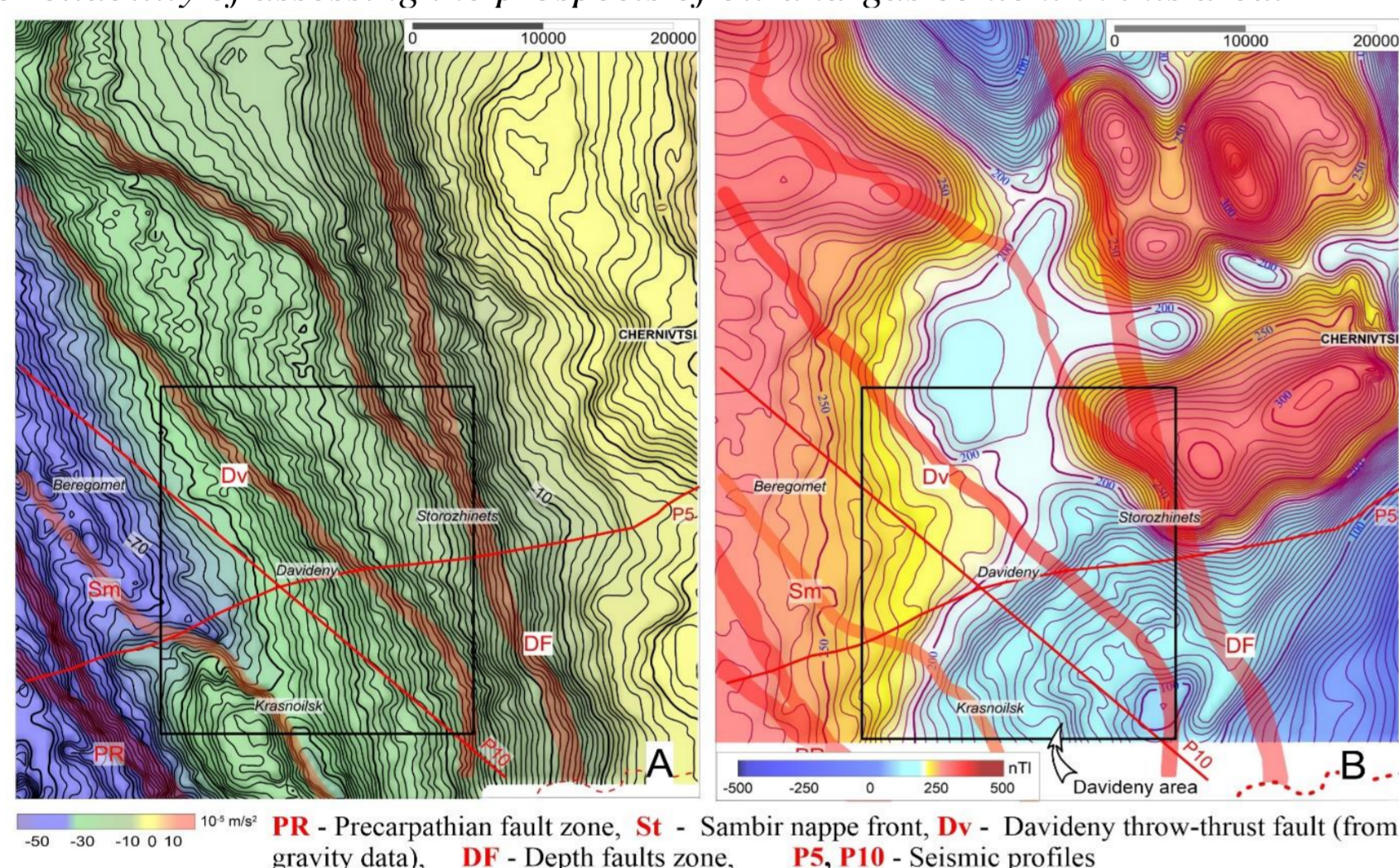


Figure 1 The anomalous gravity field (A) and magnetic fields (B) of the southeast

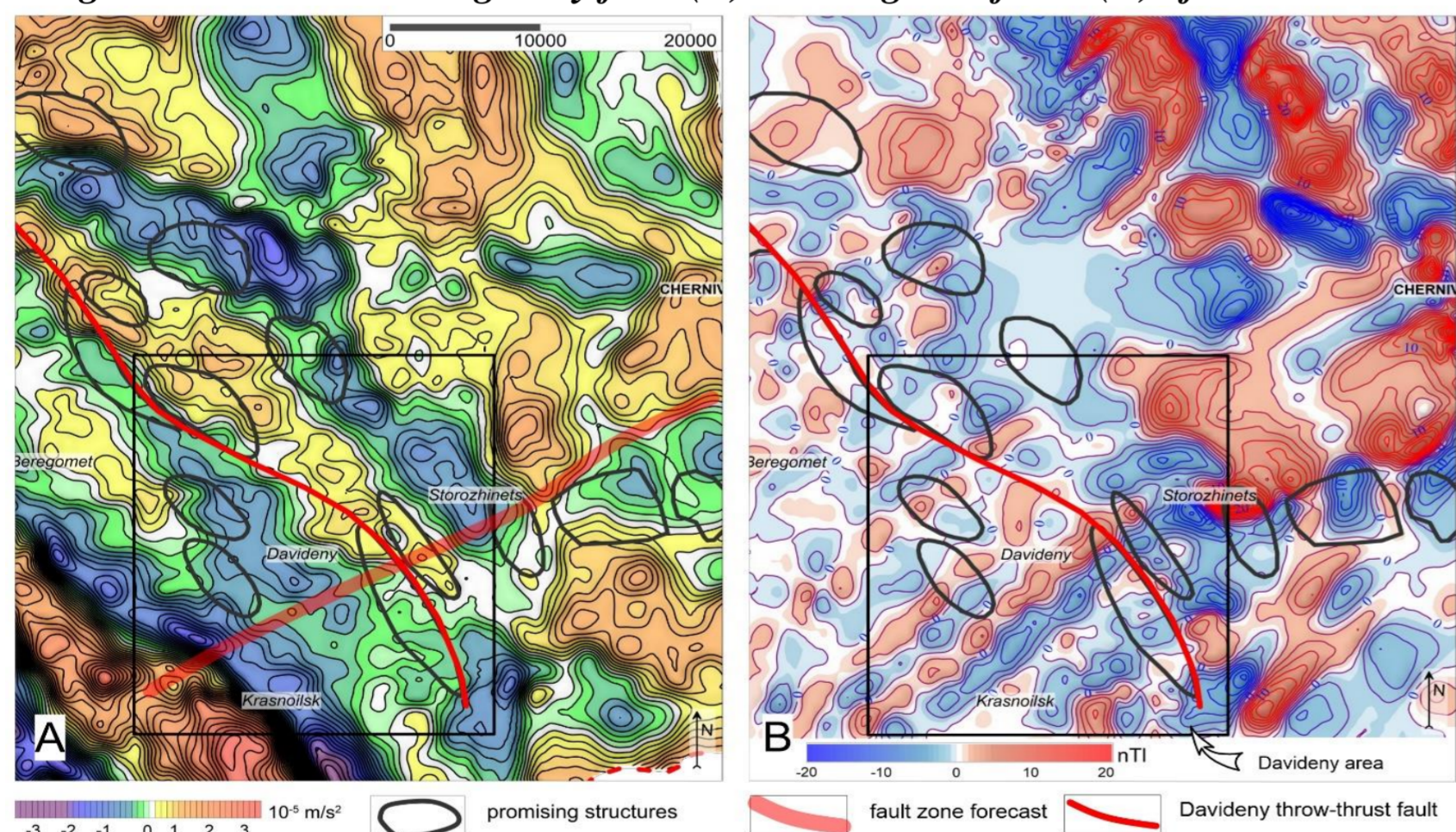


Figure 2 The perspective Ordovician objects and the gravity (A) and magnetic (B) local anomalies of the southeast of Volyno-Podillya

Methods.

The interpretation of the gravity and magnetic fields M 1:50000 was carried out by analysing the morphology of local anomalies, and according to the results of the 3D gravity inversion was determined the probability distribution of densities within the Davideni area over the Mesozoic and Paleozoic strata by using the structural maps and seismo-geological models by Kh. B. Zayats.

The local anomalies of gravity and magnetic fields are determined by transformation of averaging with a radius over which, in the conditions of the southeast of Volyno-Podillya, most of the identified anomalies are caused either by the upper part of the basement or by sources which above the basement (the averaging radius of the gravity field is 7000 m, and the magnetic one is 3000 m).

The creation of a 3D density model of geological environments, which corresponds to observed gravity field and formalized geological and geophysical data, is achieved by solving gravity inversion by the methodology and computer technologies (S.G. Anikeyev, 1999, 2008).

Results of the Bouguer gravity field and magnetic field interpretation

The intensity of the gravity field (Fig. 1A) decreases in the south-west direction, which reflects the deepening of the basement surface. The gravity field is complicated by the influence of depth faults, raised and lowered plots in the Paleozoic complex of rock, erosion of the upper part of the Paleozoic rocks, as well as Cambrian and Precambrian rocks. The morphology of the magnetic field anomalies is mainly due to the depths of the surface and the heterogeneous magnetization of the basement blocks (within the platform slope – Fig. 1B). The increase in field intensity when approaching the edge of the platform can be explained by the influence of high amplitude of the depth regional faults. In the local gravity field (Fig. 2A) extend zones of positive and negative anomalies are clearly traced, which indicate the existence of extending uplifted and weakened lowered sections. In the south-western part of the territory, an intense negative zone of the north-western extent is clearly distinguished, is related to the Kalush fault and a branch of the Pre-Carpathian fault, but further in the same direction – zone of positive anomalies that belong to the Inner zone of the Pre-Carpathian trough [Anikeyev et al., 2016].

The objects detected by seismic prospecting (Kh. B. Zayats) generally gravitate to zones of negative anomalies (Fig. 2) (to weakened zones) or located on the slopes of uplifts, that is quite possible, given the identified promising areas along the slopes of the Kolomyia's (paleo)erosion scarp. The local anomalies of the magnetic field (Fig. 2B) mainly reflect the effect of hypsometry of the surface of the basement blocks (within the platform slope). In the direction from the south-west to the north-east, a change in the mosaic of field is observed from small anomalies (whose chains in the Folded Carpathians and in the marginal strip of the platform slope to the Davideny fault have a certain direction) to even less intense anomalies and a transition to a calmer field (transition zone). Northeast of the transition zone bounded by deep faults, the basement blocks are closer to the day surface and therefore cause large intense anomalies (Fig. 1B, 2B). As can be seen from Fig. 2B, the weakened zones and perspective objects gravitate towards the transition zone. The areas of negative magnetic field anomalies within the transition zone and which intensity increases at the submeridional deep faults reflect the deepening of the basement in front of these faults. In the southwestern part of this zone, the intersection of tectonic disturbances of the north-western and the north-eastern extent is manifested.

The band of the north-eastern strike is related to a number of promising objects and, in our opinion, is caused by the transverse fault (Fig. 2A).

Results of 3D gravity inversion

Fig. 3 presents the schemes of the predicted density distribution over the Cambrian surface, and Fig. 4 – in the Paleozoic and Mesozoic strata for the Davideny area. The schemes are obtained by solving 3D gravity inversion based on a priori model created from the seismic structural maps of the Cambrian, Paleozoic and Mesozoic surfaces (author Kh. B. Zayats).

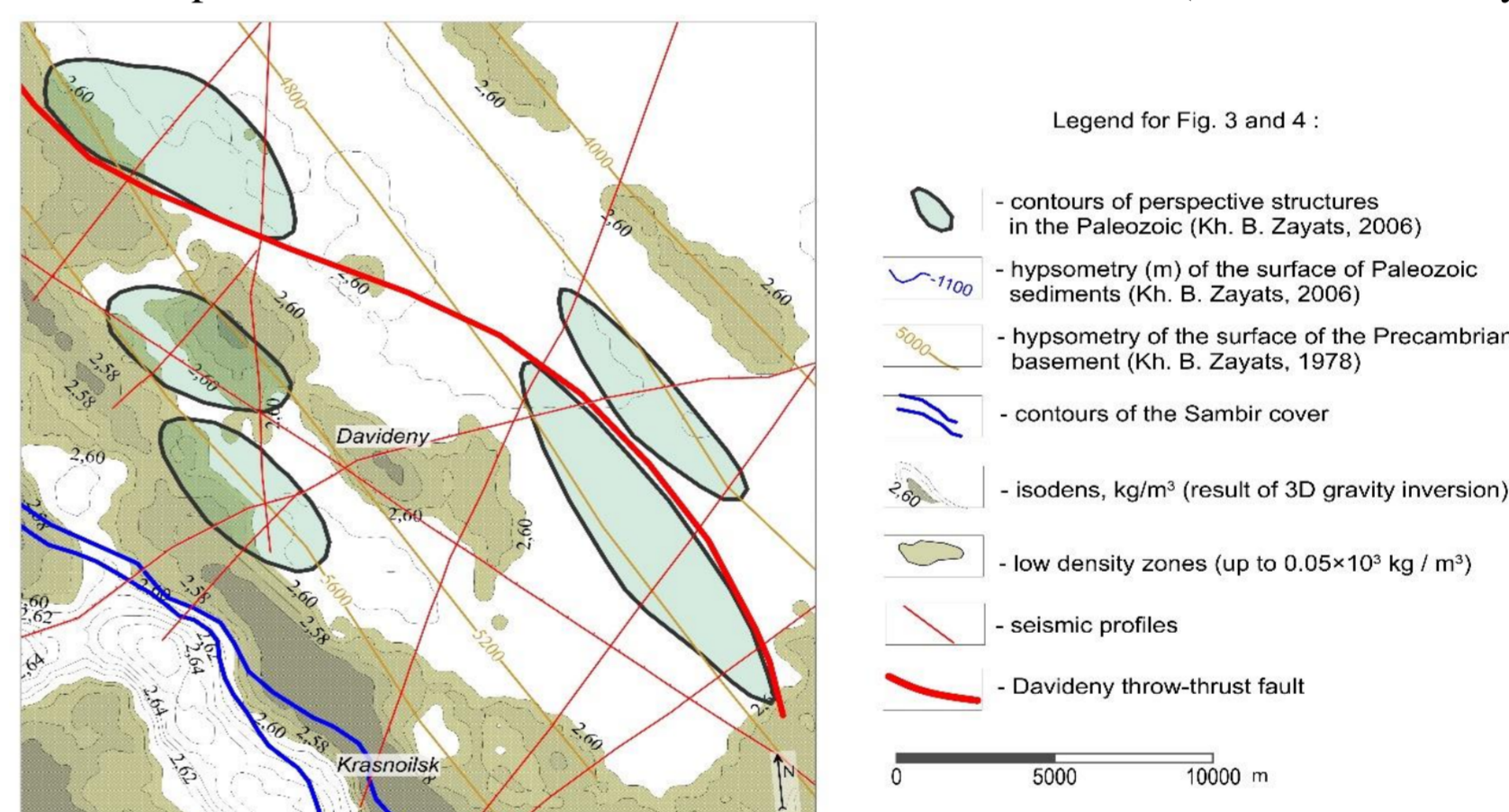


Figure 3 Davideny area. Perspective structures in the Paleozoic on the background of the Precambrian surface and zones of reduced densities above the Precambrian surface.

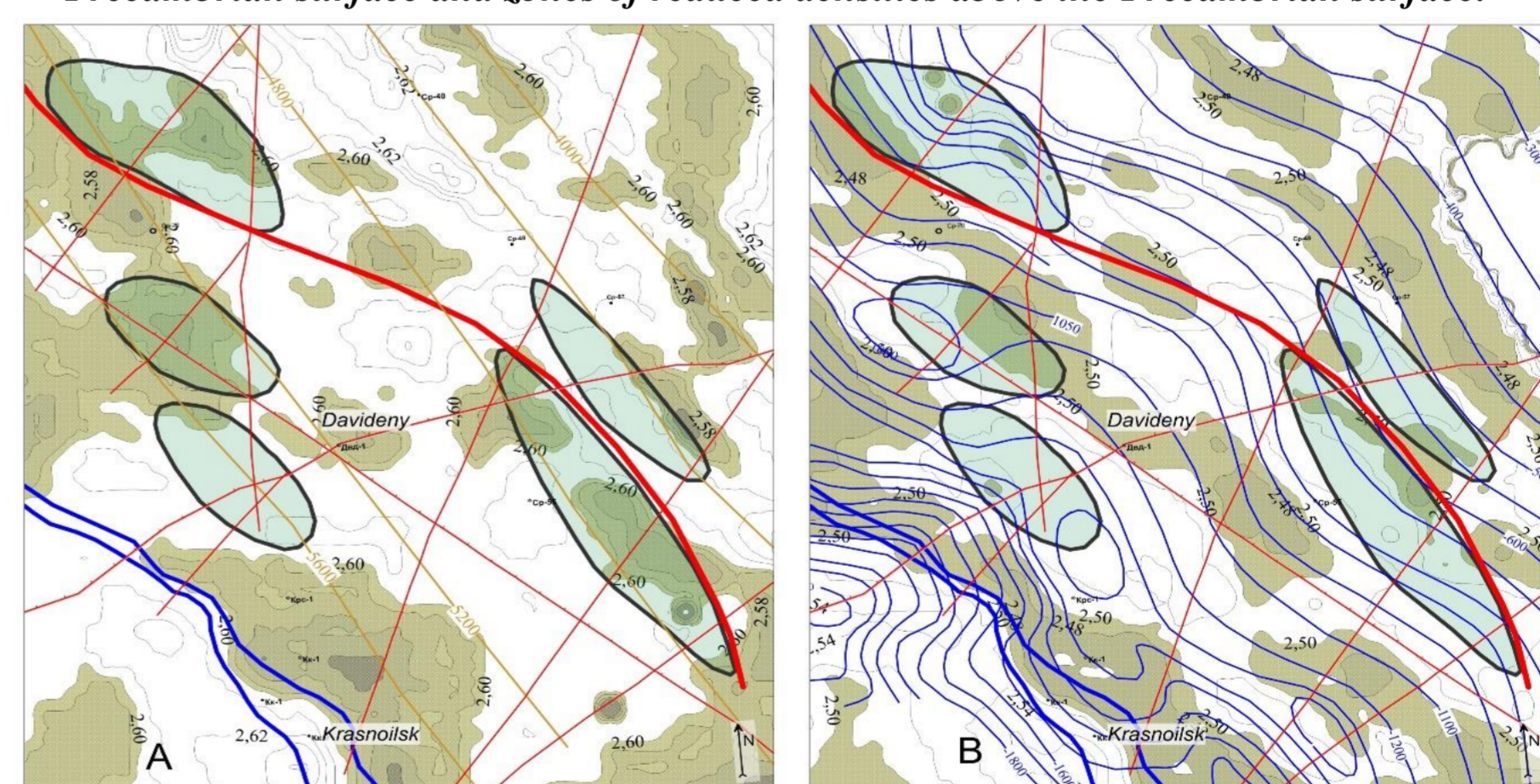


Figure 4 Davideny area. Perspective structures in the Paleozoic: A - on the background of the Precambrian surface and zones of reduced densities in the Paleozoic rocks thickness; B - on the background of the Paleozoic surface and zones of reduced densities in the Mesozoic rocks thickness.

In the 3D model bands of reduced density values are zones of weakening of rock integrity caused by lowering of the basement, by faults and adjacent throw-thrusts, or caused by erosion valleys filled with Ordovician terrigenous rocks (according to the hypothesis by Kh. B. Zayats). These zones are promising for oil and gas deposits. Up along the section (Fig. 4), as expected, there is a decrease or loss of banding and a degree increase of localization of zones of low or high density.

Conclusions

In the Carpathian region seismic studies of complex forms of depth boundaries and related complications caused by the buried tectonic zone should play an important role in the search for promising structures (Kh. B. Zayats). These data will obviously help to increase the reliability of the interpretation of gravity and magnetic fields. In our opinion, the presented gravity and magnetic materials and the 3D density model are an additional basis for a positive assessment of the prospects for the southeast of Volyno-Podillya on the discovery of new oil and gas deposits.