Concerning oil and gas potential of the underthrust uplifts within the zone of influence of the Precarpathian Fault

L. S. Monchak (Ivano-Frankivsk National Technical University of Oil and Gas), S. G. Anikeyev (Ivano-Frankivsk National Technical University of Oil and Gas), T. V. Zderka (Ivano-Frankivsk National Technical University of Oil and Gas), *N. P. Khovanets (Ivano-Frankivsk National Technical University of Oil and Gas), A. V. Yarema (Ivano-Frankivsk National Technical University of Oil and Gas)

SUMMARY

The paper studies oil and gas prospects of the Mesozoic and Neogene sediments of certain underthrust uplifts located at the edge of European Craton within the influence zone of the deep Precarpathian Fault. These uplifts are identified based on the results of the analysis of geological and geophysical evidence and according to the geological interpretation of the local Bouguer gravity anomalies including geology-gravimetical modeling with the wells data being considered. Some brief geological and tectonic characteristics of promising areas are given.
**Introduction.** The considerable amount of unexplored deep promising uplifts within the Western region of Ukraine forms the basis for increasing oil and gas resources and maintaining their development at a sufficient level. The article provides the most promising areas of a small part of the uplifted limb of deep Precarpathian Fault. The autochthonous Cretaceous and Jurassic deposits are developed within the very zone, they are presented by carbonate, clay and sand rocks. The Mesozoic unit adjacent to the fault shows oil and gas potential, since oil deposits (Kokhanivka, Lopushnia) and gas deposits (Bilche-Volytsia, U hersko, Rudkivske, and the others) were discovered within this unit. This zone is the edge of the slope of the European Craton and located under the Neogene molasse overthrust and Paleogene flysch in the south-east of the Precarpathian Depression. The oil and gas traps will happen once the Cretaceous and Jurassic reservoir rocks are overlapped by autochthonous Neogene deposits.

**Method and Theory.** According to the authors (Buderkevich et al., 1985), the complexity of the research of the pre-alpine bedrock of the Precarpathian Depression refers to the failure of the seismic marker. Therefore, the analysis of gravimetric fields is still one of the most important tools to explore the structure of the bedrock. The analysis of geological and geophysical data and reinterpretation of anomalous gravity field have been performed by means of gravity modeling; the approach and the application of the very modeling are provided in articles (Boyko and Anikeyev, 1990; Boyko, et al., 2003; Anikeyev, 2008; Monchak et al., 2010; Anikeyev et al., 2019; Monchak et al., 2020 etc.).

**Results of the geological-gravitational interpretation.** The promising underthrust uplifts are identified within the mentioned zone (Maievskyi et al., 2012; Monchak and Anikeyev, 2020). The certain uplifts indicated by positive local gravity anomalies are provided in Figure 1. *Stryi uplift* (the surface of the block of the bedrock) has a fairly large size and complex structure (Figure 1). The Mesozoic deposits build up the uplift, that is proved by the findings of the key well Stryi-1 (Figure 2). The most uplifted areas of this block constitute an exploration interest, however, the City of Stryi occupies its larger part.

**Figure 1** Local gravity anomalies map (averaging radius - 5000 m) and elevated fundament surface areas (by S.G. Anikeyev and L.S. Monchak (Maievskyi et al., 2012)

South-Stryi and Dolishnia uplifts are located in Stryi District of Lviv Region (Figure 1). They are 6,000 m × 3,000 m and 4,000 m × 3,000 m big respectively. According to the data of gravitational modeling, the depth of the top of the Jurassic deposits is expected on the isohypses -4,000 m and -5,500 m (Figure 2) (Monchak et al., 2020). These uplifts are of anticlinal nature. The Mesozoic rocks are overlapped by the Badenian deposits, that creates favorable conditions for the gas-bearing capacity of these uplifts. *Ugilnya uplift* is located east of the previous areas (Figure 1). Oil and gas prospects should be associated with the underthrust part of the Exterior (Bilche-Volytsia) of the Precarpathian Depression which is overlapped by Sambir zone. The autochthonous deposits lie on the eroded Paleozoic bedrock; these are mainly Jurassic formations while the Cretaceous and Badenian (Neogene) deposits
build up the northern part of the area. The Jurassic deposits are partly denuded and sheared by overlap fault, their full thickness was preserved only in the northern part of the area. They are characterized by carbonate and clay and sandy rock mass which involves both reservoir and cap rocks. The results of the interpretation of the gravimetric data are presented in Figure 3 (local Bouguer anomalies), Figure 4 (structure map of the paleozoic sediment cover) and Figure 5 (geodensity cross-section).

Figure 2 Geographical-gravitational model of Truhanyv-Stryi cross-section – fragment from S.G. Anikeyev and L.S. Monchak (Maievskyi et al., 2012).

Figure 3 Ugilnya area. Local Bouguer anomalies (averaging radius - 2500 m)

Figure 4 Ugilnya area. Schematic structural map of the Paleozoic sediment cover (L. S. Monchak)

Ugilnya uplift, located within the closed isohypse -2,300 m, is 6,000 × 4,000 m² big and the height of the uplift exceeds 250 m (Monchak and Anikeyev, 2020). The north-western part of Ugilnya uplift is complicated by erosional valley which is filled in with the Badenian deposits (Figure 4, 5); that can contribute to both accumulation and generation of gas.

Pechenyzhin uplift is located in Kolomyia District of Ivano-Frankivsk Region. The oil and gas prospects are associated with the downthrown part of the Exterior of the Precarpathian Depression (Bilche-Volytsia zone); the very part situated under Stebnytsia overthrust (Sambir zone). According to the wells data, the thickness of the overlapped Neogene unit ranges from 1,100 to 1,300 m within upstanding blocks and from 2,200 to 2,800 m within the downthrown blocks. The Jurassic, Cretaceous and Badenian (Neogene) deposits lie on the eroded surface of the Silurian rock masses that are the bedrock of the Exterior of the Precarpathian Depression. The results of the interpretation of gravimetric data (Figure 6) is shown in Figure 7, 8.
The downthrown block, where Kliuchiv uplift was discovered, constitutes the interest (Figure 7). This territory is restricted in the north and east by the tectonic fault, which amplitude is up to 1,700 m; the very fault is the branch of the PreCarpathian Fault. The uplift is 3,500 m × 2,200 m big across the eroded surface of the Cretaceous deposits and located within the closed isohypse -2,300 m. There are two deep wells beyond this isohypse where drilling is suspended in Mesozoic deposits at the depths of
3,096 m and 2,922 m respectively. Therefore, the Neogene and Mesozoic reservoir beds are water-bearing here.

In addition to reservoir beds, there are qualitative cap rocks in the section presented by clay and saline rocks that overlap the Mesozoic formations. Besides, the presence of Yablunivka gas field (located within an upstanding block) and Lopushnia oil field (located in similar geological conditions) indicate the potential of the very area. The uplifted block has oil and gas prospects too; two uplifts (Pechenizhyn and Verbizh) are identified within this block. The wells drilled beyond these uplifts helped to discover the full section up to eroded Paleozoic bedrock. Stratum water and gas were extracted from the Badenian deposits in well 54-BP and gas-cut water was obtained from the Badenian, Cretaceous and Jurassic deposits in well 27-BP; the above-mentioned shows the prospects of the uplifts. Pechenizhyn uplift, located within the closed isohypse -1,000 m, is 4,500 m × 2,200 m big, and Verbizh uplift, located within the closed isohypse -1,300 m, is 3,000 m × 2,000 m big. Geological-gravity modeling for the cross-section I-I (Figure 8) revealed the areas of better reservoir properties (uncompacted rocks) within the Jurassic and Cretaceous deposits of the crest part of Kliuchiv uplift.

Conclusions. The geodensity models show the presence of Proterozoic and Paleozoic rocks within all the areas of the bedrock; these rocks have been divided into blocks and were affected by dislocational processes. The Mesozoic rocks lie throughout Proterozoic and Paleozoic denudated surface and are overlapped by the Neogene formations; these rocks have reservoir properties. Noteworthy, the overthrust part of the geodensity cross-section in the plan corresponds to the geological map and deep drilling data. Thus, the data obtained show the high chance of new fields discovery at moderate depths in the Mesozoic and Neogene deposits within the areas available for exploration.

References


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