

Analysis of results of surface geochemical surveys integrated with results of seismic surveys in selected areas of the Carpathian Foredeep with a view to determine their hydrocarbon potential

Surface geochemical surveys were carried out in the eastern part of the Carpathian Foredeep. The geochemical profiles were made in three study areas: Pawłosiów-Jankowice, Gać-Białoboki and Kosina-Głuchów-Sonina. In all three areas mentioned, there were taken 898 samples of soil gas by the free gas method. Additionally, in the Pawłosiów-Jankowice area, 180 measurement points were determined from which the collected soil material was used for magnetic susceptibility measurements. The obtained results were integrated with geological-seismic model.

The objectives of this study were: (i) to delineate and prioritize zones in terms of petroleum potential based on the relationship between the surface geochemical image and the anomalous seismic record; (ii) to integrate direct and indirect geochemical methods to increase the probability of correctly locating deeper accumulations; (iii) to assess the relationships and dependencies between geochemical indicators in terms of determining the nature of hydrocarbon dispersion sources and their relative depth.

The geochemical-geological interpretation, based on concentrations of light gaseous hydrocarbons recorded in the near-surface zone, showed that light alkane components, i.e., mainly methane and ethane, migrate to the near-surface zone from relatively shallow layers of Miocene formations. On the other hand, heavier hydrocarbon components are the result of migration from deeper Miocene horizons. The values of geochemical coefficients indicated variable character of penetration of hydrocarbons from condensate-gas sources, which implies their location in deeper lying layers of Miocene succession. In addition, the relatively low values of $C_1 / \Sigma(C_2 - C_5)$ confirmed that methane of deep-seated origin was recorded in most of the soil gas samples. The assessment of correlation relationships between the concentration sets showed the weakest compatibility between methane and carbon dioxide, which proves that microbial oxidation of methane takes place in the near-surface zone. On the other hand, the analysis of relationship and dependence between changes in the value of the soil mass magnetic susceptibility and changes in concentrations of the sum of alkanes $C_2 - C_5$ in soil gas samples showed that they have a “compensatory” character. That is, where alkane concentrations

increased, negative magnetic anomalies were observed. It was considered that this could be related to the intensity of oxidation processes, the reduction of magnetic minerals in the soil or to the reduced permeability of the Miocene layers.

Altogether 11 zones of anomalous concentrations of total alkanes C₂-C₅ were examined in the three studied areas. The zones were most frequently located on slopes of palaeovalleys of Miocene basement, not necessarily in top parts of these structures, which indicates their connection with conventional natural gas accumulations. The zones indicating high probability of occurrence of hydrocarbon accumulations were selected taking into account character of obtained anomalous zones, their range, amplitude, distribution in proximity of documented natural gas accumulations and mutual relations between geochemical indicators. The most optimal zone is situated in the Pawłosiów-Jankowice exploration area and two subsequent ones in the Gać-Białoboki area.

The recorded near-surface geochemical effects may be an important supplement to traditional exploration methods and may significantly help in understanding the complex hydrocarbon migration processes occurring in the Miocene formation of the Carpathian Foredeep.