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SUMMARY

The Lublin IG 1 borehole achieved its main objective of exploring the geological structure of the central part of the Lublin Graben in terms of lithological, stratigraphic and tectonic development. The second, equally important purpose of the drilling was to determine the possibility of hydrocarbon accumulations. Upper Devonian nodular limestones revealed numerous shows of crude oil. The Middle Devonian deposits contain natural gas. From the depth of 2468.0 m downward, light crude oil of greenish colour was observed in numerous fractures and caverns. Below the depth of 4415.0 m, the content of methane rapidly increased above 25%. Simultaneously, specific gravity of the drilling mud decreased below 1g/cm^3, and viscosity increased to over 80 sec/500 cm^3. During the well flushing procedure the drilling mud was pushed out of the drill hole by gas cushions, up to an altitude of several metres above the table. These hydrocarbon shows kept on appearing all the time during drilling through the Middle Devonian section, indicating the occurrence of a natural gas deposit of economic importance. For fear of the possible eruption, over 100t of barite was added to the drilling mud at the depth of 4473.0 m to make it heavier. As the consequence, no economically important amounts of natural gas were detected. Barite, added to the drilling mud of very low strength, immediately caused the mud to settle out to resulting in a complete closure of the fractures which were the pathways for the gas to flow into the drill stem. It also had a negative effect on the hydrostatic pressure or the pressure lower than hydrostatic.

A long-term drilling break, lasting between March 15th and August 30th, 1968, due to the lack of a blow-out preventer, also had a negative influence on the gas deposit exploration. It was also noticed that, despite the confirmed inflow of hydrocarbons during the mounting of the formation tester after casing cementing operations and opening of the horizon by perforating, no gas flow was observed, indicating a negative effect of casing on the deposit. There are some doubts, too, as for the effectiveness of the acidizing method applied for marls and carbonates in the Lublin IG 1 borehole. During that procedure, products of the reaction between the carbonate and the acid, such as clay minerals and water, were injected under high pressure into fractures, pushing away the resident hydrocarbons.

The very important operation of flow intensification, i.e. oil fracturing, has not been performed in the Lublin IG 1 borehole due to unavailability of high pressure generating units.

The increased apparent thickness (borehole curvature) of the Lower Devonian deposits made it impossible to penetrate their basement. Due to technical reasons (pressure on pumps of 200 ATM), the drilling was stopped at the depth of 5028.0 m.

New research results. 38 years have passed since the Lublin IG 1 borehole was completed. During that period, especially over the last decade, interdisciplinary geological research has been conducted at the Polish Geological Institute within the framework of many scientific projects, grants and doctoral dissertations.

The present volume contains the results of the newest research performed based on investigations of drill core data and well logs interpretations. Relatively long total drill core recover, good condition of the drill core and the available borehole geophysical measurements enabled to carry out sedimentological, stratigraphical, petrographical, tectonic and geochemical investigations. They are complemented by analyses of organic matter, thermal history and tectonic subsidence rate. This volume includes the results of detailed lithological, stratigraphical, petrographical and geochemical investigations of the Devonian deposits from the Lublin IG 1 borehole. As a result, a complex lithological and petrographical suite of characteristics is presented with reference to the current chronostratigraphic scheme.

The Carboniferous stratigraphy in this borehole was updated and the boundaries were more accurately re-established by correlating the boundaries of depositional sequences to marker sections of neighbouring boreholes, and to the global and West European Carboniferous stratigraphic schemes.

The lithofacies development and the depositional architecture of the Carboniferous deposits were reconstructed, with particular regard to sandstone lithosomes as potential hydrocarbon reservoirs.

The results of investigations of heavy minerals from the Carboniferous rocks indicate the evident change within the Late Carboniferous source area. The results of porosity, permeability and pore space research suggest good reservoir properties of the Westphalian and Namurian sandstones. Reservoir properties of the Visean sandstones have appeared to be poor.

On the basis of the newest structural analyses of drill cores, several phases of tectonic deformations were identified.

New investigations were conducted on the lithology, sedimentology and stratigraphy of the Middle Jurassic section. These deposits were also examined in terms of petrography and microfacies analysis. The Cretaceous succession not only has a chronostratigraphic subdivision, but there are also geophysical units distinguished which are good correlative horizons.

Geochemical investigations of organic matter showed that the Carboniferous deposits are source rocks favourable for hydrocarbon generation. The Upper Devonian carbonates contain enough organic carbon to be considered good source rocks, too. The Middle Devonian rocks are poor both in organic carbon and bitumens.

The Carboniferous (Westphalian and Namurian) deposits contain large amounts of authigenic organic matter of a humic type (gas-generating) with considerable contribution of primary macerates of the liptinite group (oil-generating). The Visean rocks are much poorer in organic matter, but they contain an increased (as compared to Westphalian and Namurian deposits) amount of "oil-generating" algal material.

Thermal maturity of the Carboniferous deposits increases with the burial depth and corresponds to the main phase of crude oil generation at the maximum temperature of diagenesis below 100°C.

The analysed Upper and Middle Devonian rocks contain quite abundant organic matter, whereas the topmost portions of the Devonian section are very poor in organic matter. Thermal maturity of the Devonian rocks is very high and corresponds to the overmature stage of hydrocarbon generation (at the maximum temperature of diagenesis up to 250°C), in which non-economic, high-methane, dry gas can be generated.

This volume also includes the results of analyses of tectonic subsidence history and sedimentation rate for the Lublin Basin reconstructed from the Lublin IG 1 data. The analyses of thermal history, burial conditions and the history of hydrocarbon generation and expulsion are also given.

Interpretation of seismic data enabled showing the location of the borehole within the regional geological setting. The quality and the possibility of well logs interpretations, results of drill stem tests, and chemical analyses of crude oil and natural gas recovered from the tested formations of the Lublin IG 1 borehole were also discussed.