Zdzisław MODLIŃSKI

SUMMARY

The Darżlubie IG 1 borehole, located in the western part of the Baltic Depression, pierced the whole sedimentary cover and reached the top of the crystalline basement at the depth of 3509.0 m. The top surface was drilled only 9 m (!) deeper than that assumed in the section interpreted based on reflection seismic surveys of 1968. The crystalline basement is composed of Paleoproterozoic granitoids (stromatitic migmatites) hydrothermally altered at the top.

The crystalline rocks are immediately overlain by the Żarnowiec Formation (Ediacaran–lowermost Lower Cambrian), 19.0 m thick (depth 3490.0–3509.0 m), represented by vari-grained sandstones and conglomerates.

Cambrian deposits were drilled in a depth interval of 3003.0–3490.0 (487.0 m in thickness), and the section is represented by all the three Cambrian units: lower, middle and upper. Due to difficulties in biostratigraphic correlation between the Cambrian sections of Poland and the new global chronostratigraphic schemes of the System, the traditional, tripartite subdivision is used in this volume. Within the Cambrian section, the drillhole is almost fully cored to be the standard section for the area of western Baltic Depression. The drill cores have been comprehensively analysed for stratigraphy, sedimentology and petrography, and tested for physical and chemical properties.

Ediacaran and Cambrian deposits correspond to the first (Ediacaran–lower Middle Cambrian) and second (upper Middle Cambrian–Upper Cambrian) Ediacaran–Lower Paleozoic depositional sequences of the sedimentary cover in the East European Craton. There is a huge disparity there in the thickness between the first and the second sequence. The first sequence in the Darżlubie IG 1 borehole is over 50 (!) times thicker than the second sequences. Large thickness variations of these sequences are due to the different phases of the geotectonic development of the sedimentary basin in the marginal part of the present-day East European Craton (Jaworowski, 1999, 2002). The first sequence was deposited during a period of strong subsidence that accompanied extension resulting in the breakdown of the Precambrian Rodinia supercontinent. The strikingly lower thickness of the second sequences is a result of much slower subsidence typical of the thermal subsidence stage in the sedimentary basin development.

Ordovician deposits occur at a depth of 2933.0–3003.0 m reaching a thickness of 70.0 m. The section includes Lower Floian through Hirnantian deposits represented by the four lithostratigraphic units (from bottom): Słuchowo Claystone Formation, Kopalino Limestone Formation, Sasino Claystone Formation and Prabuty Marl and Claystone Formation. This section is characterized by a clear predominance of clay deposits over limestones, and this lithology corresponds to the so-called Scania Confacies constituting the inner zone of the Ordovician Baltic Basin.

A thick complex of Silurian deposits was found at a depth of 1071.0–2933.0 m, thus its thickness is 1862.0 m. The Silurian section includes all of its Series from the Pridoli through the Llandovery. It is dominated by clay deposits with abundant graptolitic fauna, and only the upper part of the section, within the Kociewie Claystone and Siltstone Formation (Ludlow–Gorstian) appear inserts siltstone interbeds are observed. The Puck Calcareous Claystone Formation (Upper Ludlow–Pridoli) contains marl and marly limestone interlayers.

The scoured surface of the Upper Silurian-Pridoli deposits is directly overlain by Upper Permian-Zechstein deposits, 311, 0 m in thickness (depth 760.0–1071.0 m). This is a typical section for the NW part of the palaeographic Baltic Bay. Three carbonate-evaporitic cyclothems of PZ1, PZ2 and PZ3 and the cyclothem PZ4 are represented here by the Top Terrigenous Series (PZt).

The Mesozoic succession has a total thickness of 612.0 m, containing major stratigraphic gaps, is represented by fragments of Lower and ?Upper Triassic, Middle Jurassic (Upper Bathonian-Callovian), Upper Jurassic (Oxfordian), and Upper Cretaceous (Cenomanian–Lower Coniacian) deposits.

Geochemical analyses of organic matter were fragmentarily carried out on Cambrian, Ordovician and Silurian rocks. The amount of organic matter is varied, and only the Caradoc deposits – Sasino Claystone Formation and partly Wenlock deposits – Pelplin Claystone Formation can be considered as “good source rocks”. By contrast, Ludlow and Llandowery deposits can be regarded as “poor source rocks” for hydrocarbon generation.

The degree of organic matter alteration in the Lower Paleozoic succession generally increases with age and burial of the deposits and corresponds (in Middle Cambrian, Ordovician and Silurian deposits) to the late stage of oil generation with the possibility of wet gas and condensate generation. Diagenesis of these deposits proceeded at the maximum palaeotemperatures probably of around 100–130°C. Lower Cambrian rocks show significantly higher thermal maturity and fall within the main phase of gas generation (1.52–1.61% R_O) at the maximum palaeotemperatures of up to 180°C.

Hydrogeological investigations performed in the borehole included tests of seven horizons: one in the Permian and six in the Cambrian. Their primary task was to investigate the Cambrian reservoir horizons for the presence of hydrocarbons and to determine their detailed hydrogeological characteristics. Although the test revealed traces of oil and gas in the Cambrian deposits, but the sampling shows that these horizons are characterized by very poor reservoir properties, or their lack.

Laboratory tests for physical parameters of the Cambrian sandstones also confirm their poor quality for migration and accumulation of hydrocarbons. Effective porosity of the Middle Cambrian deposits varies from 0.1 to 10.1% and there is only one small package of sandstones (depth 3098.5–3100.5 m) in which the effective porosity is 5 to 10% and the permeability reaches a maximum of about 3500 nm^2. The Lower Cambrian succession contains longer sections of rocks showing porosity of around 5–10%, however their permeability is very low. As demonstrated by petrographic studies, reduction of the original porosity of the sandstones was influenced by compaction and cementation processes. Intergranular voids remaining after cementation are in the form of isolated, very small pores.