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PROGNOSTIC ACCUMULATION ZONES FOR OIL AND NATURAL GAS IN THE CRITERIA FOR THE DISTRIBUTION OF PETROPHYSICAL PARAMETERS IN THE MAIN DOLOMITE IN GORZOW-PNIEWY AREA

PROGNOSTYCZNE STREFY AKUMULACJI DLA ROPY NAFTOWEJ I GAZU ZIEMNEGO W KRYTERIACH ROZKŁADU PARAMETRÓW PETROFIZYCZNYCH DOLOMITU GŁÓWNEGO W OBSZARZE GORZÓW-PNIEWY

The carbonate reservoirs are anisotropic environments in terms of both the quantitative and qualitative evaluations of pore space. The oil-and-gas-bearing Main Dolomite horizon shows diversified lithology, facial development and thickness resulting in complicated, fluid capacity-fluid filtration system.

This system influences both the evaluation and exploration perspectives in the Zechstein Main Dolomite (Ca2) from the Gorzów-Pniewy area.

In order to clarify this problem and to determine the hydrocarbon accumulation perspectives, analysis of petrophysical parameters based upon the porosimetric measurements was carried on for the Main Dolomite in the study area, where oil and gas accumulations were discovered.

The results of porosimetric measurements clearly indicate the heterogeneity of petrophysical parameters of the Main Dolomite referred to lithologically diversified palaeogeographic zones distinguished in the study area.

Such analysis, including the hydrocarbon storage capacity of the Main Dolomite, enabled us to evaluate the possible hydrocarbon accumulation related to generation potential of this horizon.

Keywords: Main Dolomite, Grotów peninsula, subfacies of the Main Dolomite, petrophisical parameters

W ocenie ilościowej i jakościowej przestrzeni porowej środowiskiem anizotropowym są węglanowe skały zbiornikowe. Zróżnicowany litologiczno-facjalnie oraz miąższościowo, ropo-gazonośny poziom dolomitu głównego charakteryzuje się złożonym układem pojemnościowo-filtracyjnym.

Tym regułom podporządkowana jest ocena i perspektywy poszukiwawcze w cechsztyńskim poziomie dolomitu głównego (Ca_2) w Polsce w rejonie Gorzów-Pniewy.

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W celu uprządkowania tego zagadnienia i prognozy perspektyw złożowych, w oparciu o wyniki badań porozymetrycznych, przeprowadzono analizę parametrów petrofizycznych dolomitu głównego w przedstawionym obszarze, o stwierdzonej ropo-gazonośności tego poziomu.

Wyniki badań porozymetrycznych wyraźnie wskazują na heteregoniczność utworów dolomitu głównego w zakresie zmienności parametrów petrofizycznych, odniesionych do zróżnicowanych litologicznie stref paleogeograficznych w analizowanym obszarze.

Analiza ta, w odniesieniu do pojemności magazynowej dolomitu głównego, rozwiniętego w zróżnicowanych facjach poszczególnych stref paleogeograficznych, pozwala na ocenę możliwej akumulacji węglowodorowej, w stosunku do potencjału generacyjnego tego poziomu.

Słowa kluczowe: Dolomit Główny, półwysep grotowa, subfacje dolomitu głównego, parametry petrofizyczne

Introduction

The decisive factors in hydrocarbon accumulation are both the reservoir and cap rocks genetically linked to sedimentary and post-diagenetic processes, and arranged as a trap formed during the structural evolution of petroleum basin.

Genetically diversified and structurally complicated reservoir rocks show very heterogenous distribution patterns and values of physical parameters as well as porosity and permeability, which control the type of pore space and, consequently, influence their filtration, and capacity properties. This heterogeneity depends in various proportions on the character and the type of depositional environment during the sedimentary stage of basin history along with diagenetic processes operating during the tectonic rearrangement of the basin.

The carbonate reservoir rocks show remarkable, quantitative and qualitative anisotropy of the pore space. Such anisotropy is observed in the Main Dolomite oil and gas horizon, which shows complicated capacity and filtration patterns resulting from lithological, facial and thickness diversity.

These factors influence the evaluation of hydrocarbon potential and exploration perspectives of the Zechstein Main Dolomite (Ca2) in the Gorzów-Pniewy area in Poland where hydrocarbons have been discovered.

The following analysis of petrophysical parameters of the Main Dolomite based on the results of porosimetric measurements aims to clarify the problems of hydrocarbon potential and to provide prognoses for commercial accumulations.

The results of porosimetric measurements indicate distinct heterogeneity of the Main Dolomite in terms of petrophysical parameters referred to lithologically diversified palaeogeographic zones distinguished in the study area. The analysis of parameters referred to storage capacity of the Main Dolomite facially diversified in particular palaeogeographic zones enables the geologists to evaluate potential hydrocarbon accumulation related to generation potential of this horizon.

In order to evaluate the storage capacity of the Main Dolomite in the Gorzów-Pniewy area we used the available results of porosimetric measurements carried on at the Oil & Gas Institute in Kraków and at the Department of Fossil Fuels, Faculty of Geology, Geophysics & Environment Protection, AGH-University of Science & Technology in Kraków. These data were processed in order to estimate the hydrocarbon potential of the Main Dolomite horizon (Such, 2002; Such et al., 2002-2005).

The dataset included the results of porosimetric measurements of drill cores derived from the wells located in distinguished palaeogeographic zones: platform foreslope (Lubiatów-1, -2, -4, Sowia Góra-1, -2k and -4 wells), carbonate barrier (Dzierżów-1, -1 bis, Międzychód-3, -4, -5 and -6 wells) and platform shoal (Ciecierzyce-1, Grotów-1, -2, Santok-1 and Sieraków-1 wells) (Fig. 1).

The porosimetric measurements of the Main Dolomite were carried on samples representing diversified microfacies determined by particular sedimentary environments. The three main groups of microfacies were distinguished:

1 – **bandstones** (including the microbial mats and buildups),
2 – **mudstones and wackestones**,
3 – **packstones, grainstones, floatstones and rudstones** (Jaworski & Mikołajewski, 2007; Mikołajewski, 2007, 2012; Semyrka et al., 2007, 2012; Wagner, 2004).

1. Categorization of pore space

The crucial problem of hydrocarbon exploration is the evaluation of accumulation and preservation potentials of petroleum deposits, which leads to identification of reservoir and sealing rocks. This requires the detailed characterization of pore space in potential reservoirs based upon geological evaluation of reservoir horizons using the qualitative and quantitative, lithological, facial and petrophysical analyses.

The analysis of accumulation properties of particular geological formation embraces the physical characterization of their pore space. The principles of categorization of porous rocks as petroleum reservoirs include the measurement of a number of parameters: effective and dynamic porosities, permeability, geometry of pore space in terms of dominating pore diameters and specific surface area of the pore space. The pore space determines the migration and accumulation processes of reservoir fluids. Hence, its categorization is suitable for recognition of accumulation and distribution of petroleum deposits.

Evaluation of potential reservoir and sealing rocks is based upon the quantitative analysis of a number of parameters controlling the saturation and the flow of hydrocarbons within the pore space.

The physical models of the flow of homogenous fluid through the porous medium are determined by the critical pore diameters. This parameter is applied to select the classes of both the pore space and the storage capacity of reservoir rocks. This, in turn, enables us to distinguish the following groups:

a) **supercapillary interstices** of pore size $d > 100$ μm, where fluid flow is described by the Bernoulli's equation;
b) **capillary interstices** of pore size 100 μm $> d > 0.1$ μm, where fluid flow is described by the Darcy's law for linear flow;
c) **subcapillary interstices** of pore size $d < 0.1$ μm, where fluids flow due to mass diffusion, in accordance to Fick's equation (Burzewski et al., 2001).

Therefore, any rock can be identified as potential reservoir not only due to its void ratio but also due to the remaining physical parameters of pore space, especially pore size and pore size distribution, fracture aperture, specific surface area and geometry of pores pattern as a function of their size, all in supercapillary, capillary and subcapillary interstices (Burzewski et al., 2001; Słupczyński et al., 2001; Such, 2002).

In common understanding, the petroleum reservoirs are rocks of measurable absolute permeability and the value of effective porosity coefficient over 3.5%, referred to their intergranular, not fracture porosity (which is practically lower). Taking into account the Perrodon's categori-

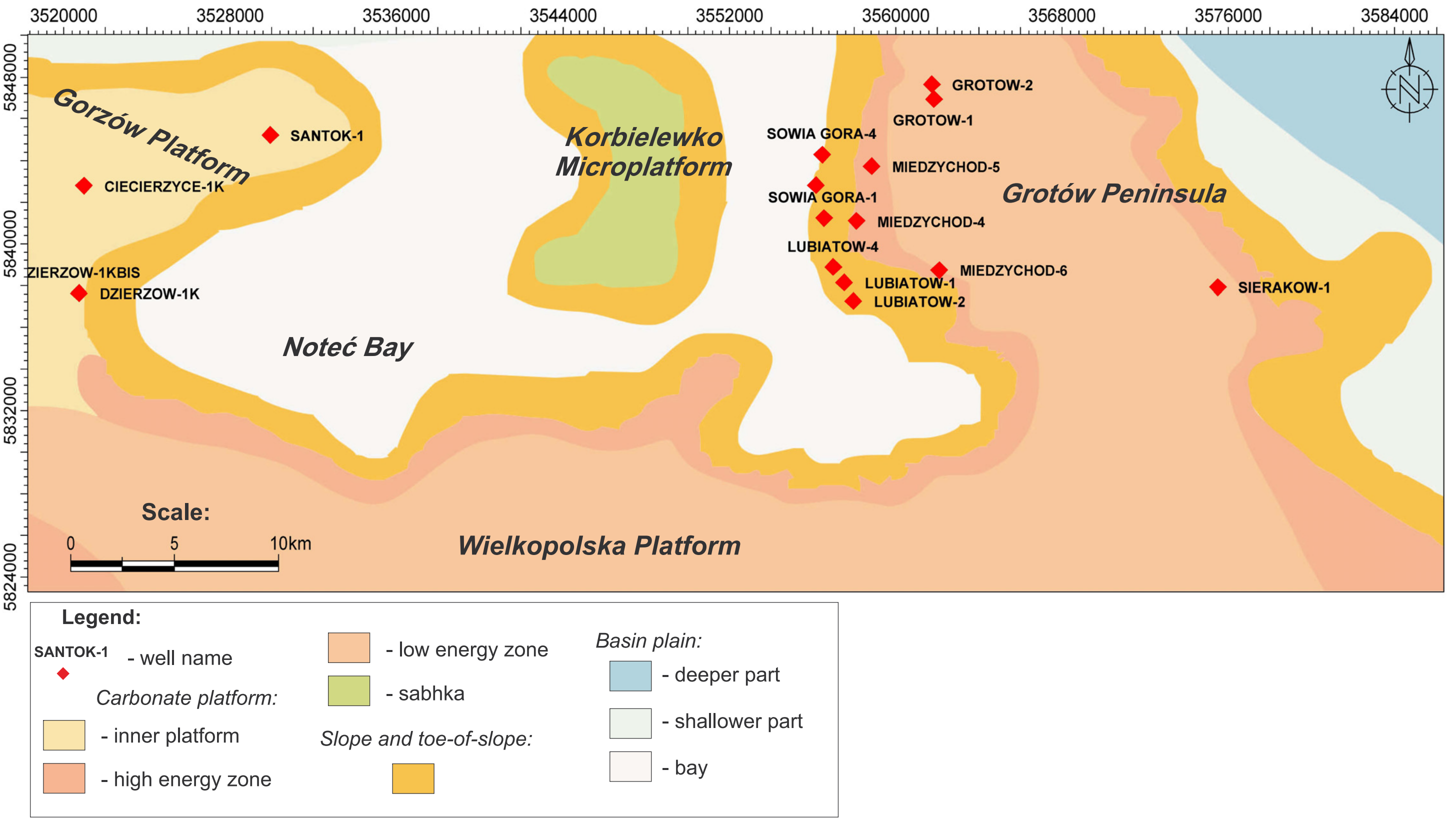

Fig. 1. Map of the study area against paleogeographic zones

zation (Perrodon, 1980) modified to the practice of petroleum exploration (Bachleda-Curuś & Semyrka 1997; Burzewski et al., 2001; Semyrka et al., 2008, 2010), five main capacity categories of reservoir rocks were distinguished:

1. **very low capacity,** when effective porosity of rocks is lower than 3.5%;
2. **low capacity**, when effective porosity of rocks falls into the range 3.5-10%;
3. **moderate capacity**, when effective porosity falls into the range 10-15%;
4. **high capacity**, when effective porosity falls into the range 15-20%;
5. **very high capacity**, when effective porosity exceeds 20%.

In this categorization, rocks of ***intergranular porosity*** from 0.0 to 3.5% are potential seals (Perrodon, 1980). However, in rocks showing ***fracture porosity*** the effective porosity values of only 1-2% enable us to categorize them as potential reservoirs of ***very low capacity***.

Both the migration and accumulation of particular hydrocarbon phases are continuous processes, starting from the moment when hydrocarbon molecules are transferred into the subcapillary interstices and coalesce into gas bubbles or oil droplets. Then, such bubbles and/or droplets migrate through capillary interstices because buoyancy force and pressure gradient exceed the capillary pressure and, thus, it enables the migration of reservoir fluids.

These considerations led us to the distinguishing the values of pore diameters $d > 0.1$ mm and $d > 1$ mm as boundary values for gas and oil migration, respectively (Burzewski et al., 2001). Hence, the **dynamic porosities for gas and for oil** can be defined as pore space indicators, which embrace both the physical properties of pore space and the type, and physical-chemical features of reservoir fluids which migrate through the rocks (Semyrka et al., 2008, 2010).

The defined dynamic porosity for reservoir fluids allows for calculation of effective capacity of particular reservoir fluid (oil, gas, water), which determines its storage capacity. These theoretical presumptions supported by the results of practical porosimetric measurements enabled us to categorize rocks as potential gas and/or oil reservoirs, or as seals, and to evaluate their physical parameters. The correct determination of petrophysical parameters is crucial in the interpretation of reservoir tests. Among other in Drill Stem Test (DST) (Dubiel et al., 2012).

2. Evaluation of petrophysical parameters of the Main Dolomite on regional scale

For evaluation of petrophysical parameters of distinguished subfacies: bandstones, mudstones and grainstones, the set of porosimetric results was used. These results were processed in order to evaluate and categorize the Main Dolomite with the reference to interpretation opportunities provided by this method (Semyrka et al., 2012). Such data interpretation enabled us to identify the types of pore space and its conventional capacity classes.

The **bandstones** can be categorized as interstitial-porosity-type reservoirs of low to moderate capacity for gas and very low to low capacity for oil.

The petrophysical parameters of **mudstones** enable us to categorize them as reservoirs of low capacity, locally of moderate capacity for both the gas and the oil.

Analysis of petrophysical parameters for **grainstones** reveals that these reservoirs show uni- or multimodal interstitial porosity commonly accompanied by fracture systems. Hence, the grainstones reveal moderate to, locally, high capacity for gas, and low, locally moderate or high capacity for oil (Semyrka et al., 2007, 2008, 2012).

Taking into account macroscopic, microscopic and porosimetric studies, it can be suggested that the crucial problem of the Main Dolomite as a hydrocarbon reservoir rock is the density and development of fracture system. In the study area, the fracture porosity of the Main Dolomite is dominated by microfractures constituting 2-3% of its capacity (Semyrka et al., 2007, 2012).

Considering all the subfacies of the Main Dolomite encountered in the study area, its categorization is best defined by the distributions of the effective and the dynamic porosities for oil (Semyrka et al., 2012).

The distribution of effective porosity is relatively balanced between the capacity categories:

12% in very low-capacity category; 24% in low-capacity category;
32% in moderate-capacity category; 15% in high-capacity category;
17% in very high-capacity category.

The dynamic porosity shows similar distribution among capacity categories:

18% in very low-capacity category; 22% in low-capacity category;
32% in moderate-capacity category; 12% in high-capacity category;
16% in very high-capacity category.

However, the distribution of dynamic porosity between capacity categories is different for the oil. It is clearly dominated by very low-capacity category supported by low-capacity one whereas other categories play minor role. The numerical results are as follows (Fig. 2):

43% in very low-capacity category; 23% in low-capacity category;
9% in moderate-capacity category; 7% in high-capacity category;
8% in very high-capacity category (Fig. 4).

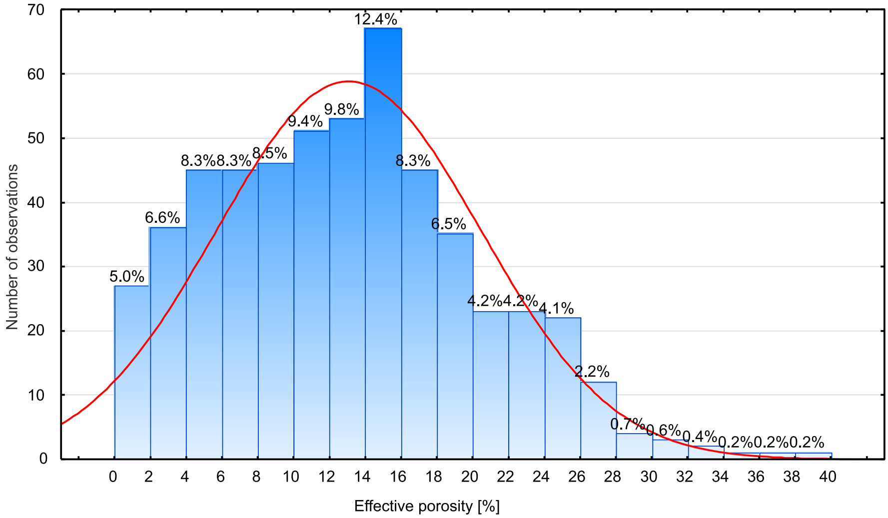

Fig. 2. Histogram of the effective porosity of the analyzed drilling profiles based on measurements of the mercury porosimeter

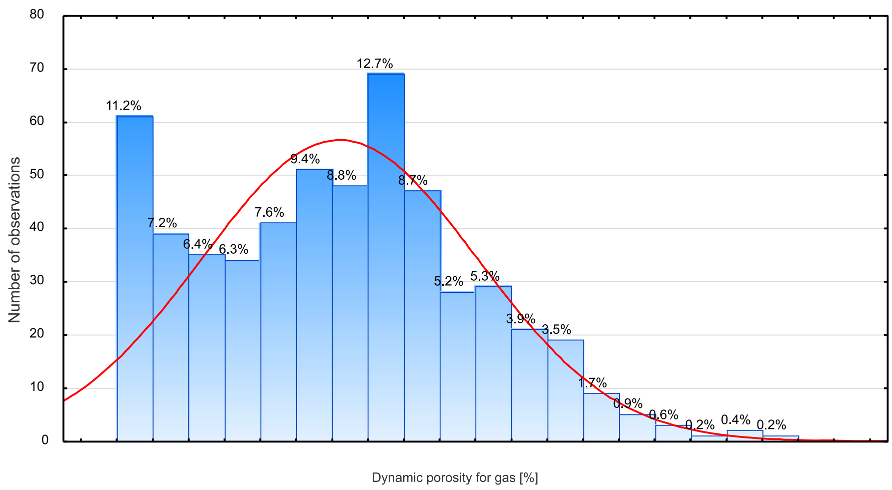

Fig. 3. Histogram dynamic porosity distribution in the analyzed gas drilling profiles based on measurements of the mercury porosimeter

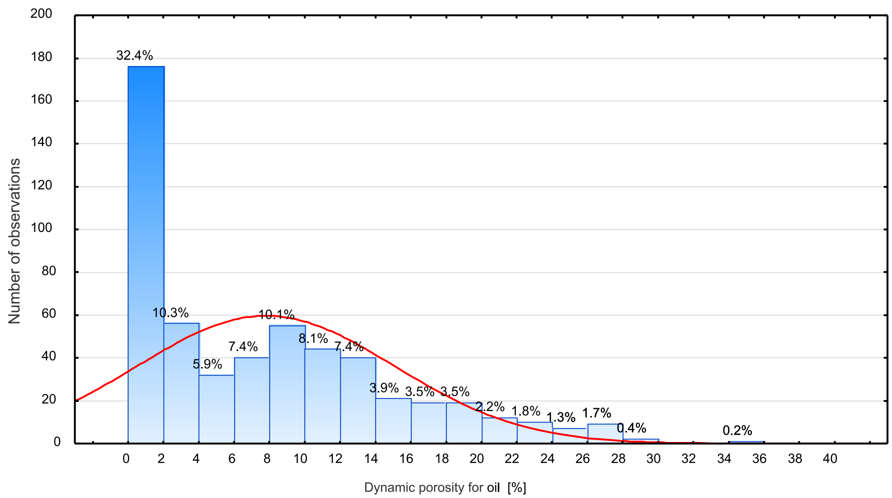

Fig. 4. Dynamic porosity distribution histogram for oil drilling in the analyzed profiles based on measurements of the mercury porosimeter

The evaluation of petrophysical parameters includes their lateral distribution pattern. The distribution map of **effective porosity** for the full sequence of the Main Dolomite shows local increase of this parameter defined by 12.5% contour. Such zones of increased effective porosity were identified in the following areas (from east to west) (Fig. 5):

- in the Grotów area where effective porosity reached almost 15% (Grotów-1 well – 14.91%),

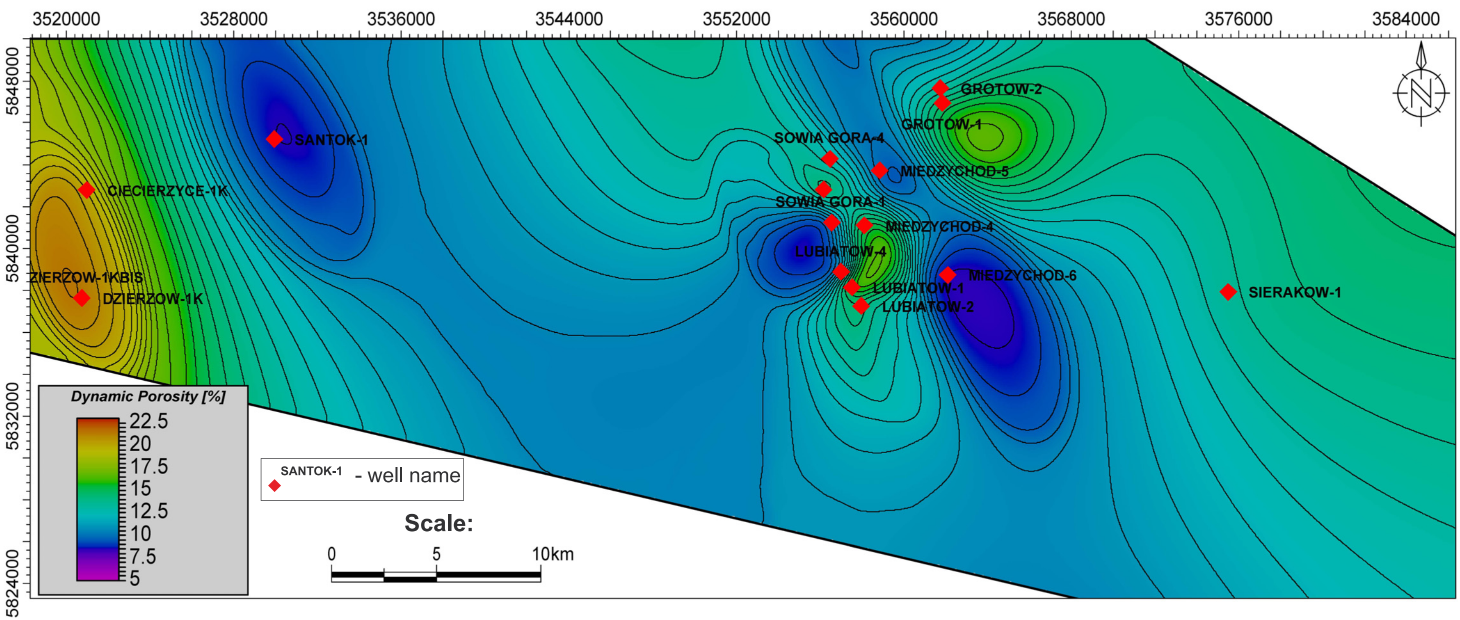

Fig. 5. Map of the trend of the average effective porosity values [Kef%] of the Main Dolomite

- in the Lubiatów and Sowia Góra areas where maximum value of effective porosity was measured: 16.90% in the Lubiatów-1 well,
- in the western part, in the Dzierżów and Ciecierzyce areas where effective porosity values reached 21.54% in the Dzierżów-1K bis well and 20.15% in the Ciecierzyce-1k well (Tab. 1).

TABLE 1

Summary of the porosity and effective capacity, dynamic for oil and gas in of the main dolomite drilling profiles

	Well name	Number of samples	Effective porosity Ke [%]	Dynamic porosity for Gas Kdg [%]	Dynamic porosity for Oil Kdr [%]	Thickness of The Main Dolomite Th [m]	Effective capacity [m3/m2]	Dynamic capacity for Gas [m3/m2]	Dynamic capacity for Oil [m3/m2]
Basin plain	Lubiatów-1	45	16.90	16.81	14.72	56.00	9.46	9.41	8.24
	Lubiatów-2	33	13.83	13.43	12.10	48.00	6.64	6.45	5.81
	Lubiatów-4	40	9.91	8.89	4.64	45.50	4.51	4.04	2.11
	Sowia Góra-1	56	8.82	8.27	6.11	47.50	4.19	3.93	2.90
	Sowia Góra-2K	45	14.94	14.17	11.84	43.49	6.50	6.16	5.15
	Sowia Góra-4	44	12.25	11.64	9.89	45.00	5.51	5.24	4.45
Barrier	Dzierżów-1K	17	15.29	14.39	8.88	55.00	8.41	7.92	4.88
	Dzierżów-1K bis	16	21.54	19.78	14.60	41.87	9.02	8.28	6.11
	Międzychód-4	37	14.98	14.15	6.08	80.00	11.99	11.32	4.87
	Międzychód-5	27	9.78	9.16	1.50	87.50	8.56	8.02	1.32
	Międzychód-6	17	8.41	7.08	0.70	48.50	4.08	3.43	0.34
Platform	Ciecierzyce-1K	9	20.15	19.66	12.68	40.00	8.06	7.86	5.07
	Grotów-1	33	14.91	14.67	9.13	33.50	4.99	4.91	3.06
	Grotów-2	40	12.77	11.95	3.93	34.00	4.34	4.06	1.33
	Santok-1	28	8.49	8.02	3.97	50.50	4.29	4.05	2.00
	Sieraków-1	56	13.37	12.83	5.54	59.00	7.89	7.57	3.27

The effective porosity values were used for calculations of dynamic porosity for gas and oil in the Main Dolomite reservoir (Tab. 1). However, because the distributions of dynamic porosities for oil and for gas were based exclusively on the results of porosimetric measurements, the obtained maps reflect only the trend of obtained dynamic porosity values.

The distribution of average values of **dynamic porosity for gas** revealed the presence of three distinct zones:

- the Grotów area in which the average dynamic porosities for gas reached 14.67% in the Grotów-1 well,
- the Lubiatów and Sowia Góra area where the highest values of average dynamic porosity for gas were measured: 16.81% in the Lubiatów-1 well and 14.17% in the oil-bearing Sowia Góra-2k well,
- the relatively extended area of Dzierżów and Ciecierzyce where maximum average dynamic porosity: 19.66% was found in the Ciecierzyce-1k well (Tab. 1, Fig. 6).

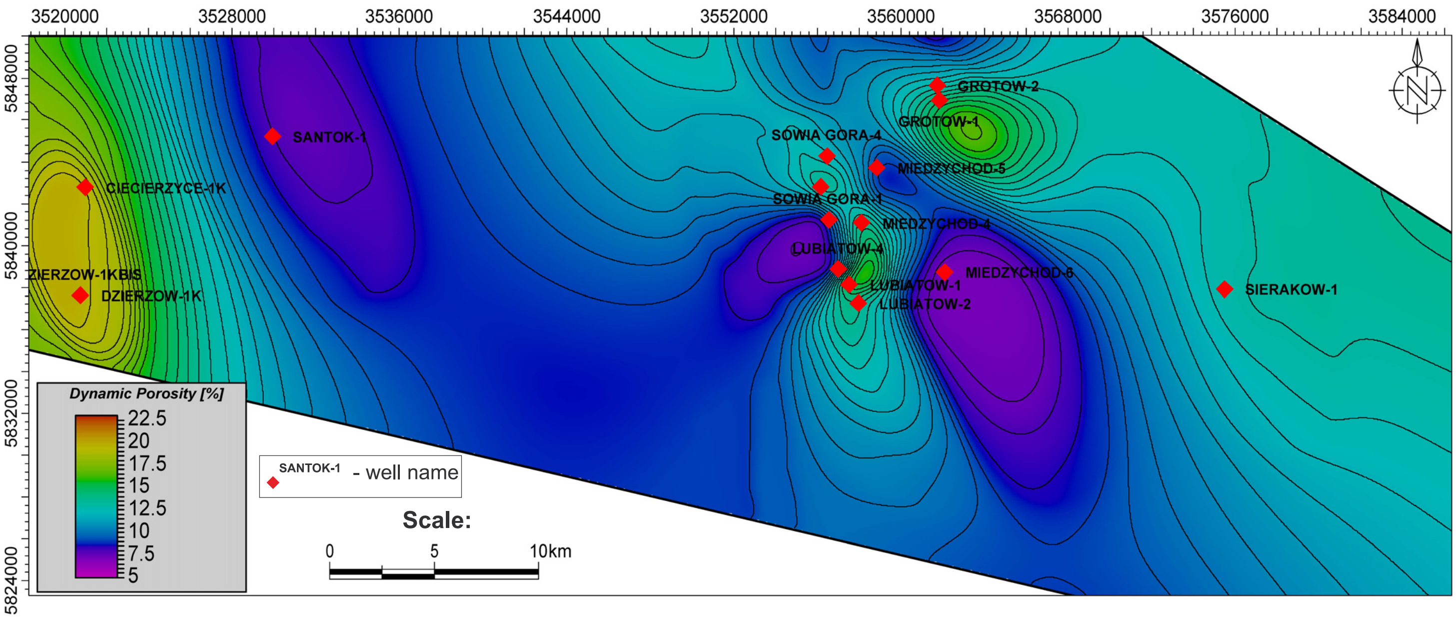

Fig. 6. Map of the trend of the average dynamic porosity values for gas [Kdg%] of the Main Dolomite

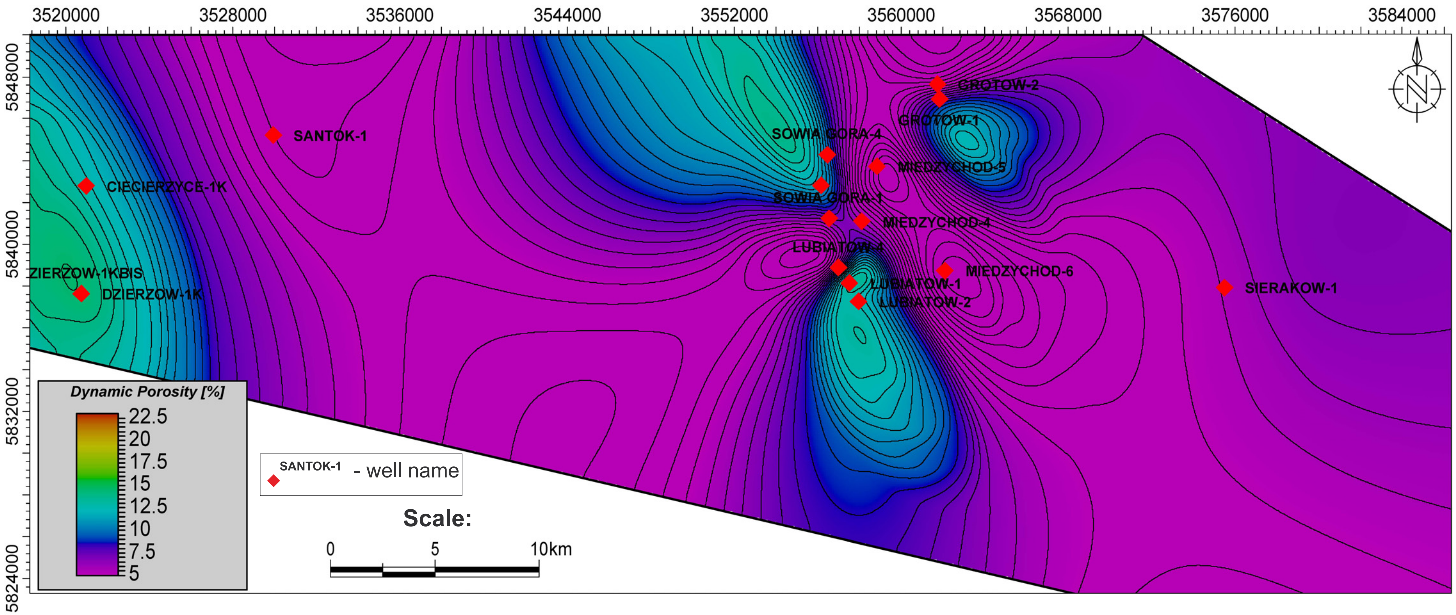

Fig. 7. Map of the trend of the average dynamic porosity values for oil [Kdr%] of the Main Dolomite

The map of average **dynamic porosity for oil** also disclosed some distinct zones:
- the Grotów area of maximum value 9.13% in the Grotów-1 well,
- the Lubiatów and Sowia Góra areas where the maximum values were found: 14.72% in the Lubiatów-1 well and 11.84% in the Sowia Góra-2k well,
- a narrow zone which separates the Lubiatów and the Sowia Góra areas in which the average dynamic porosity decreases to 5%,
- the western part of the study area (Dzierżów and Ciecierzyce) where relatively higher dynamic porosity for oil was observed in the Dzierżów-1K bis well (14.60%) in relation to 12.68% in the Ciecierzyce-1 well (Tab. 1, Fig. 7).

3. Statistical relationships of petrophysical parameters

An interesting aspect of distribution of petrophysical parameters for the Main Dolomite in the study area is the analysis of mutual relationships between the effective and the dynamic porosity values for the gas and for the oil.

Variability of effective and dynamic porosity values for the gas is low or even neglectable (Fig. 8). For example, in the Ciecierzyce-1k well the effective porosity for gas is 20.15% and the dynamic porosity for gas is 19.66%. Similarly, in the Grotów-1 well the effective porosity value K_e = 14.91% corresponds to dynamic porosity K_g = 14.72% (Tab. 1).

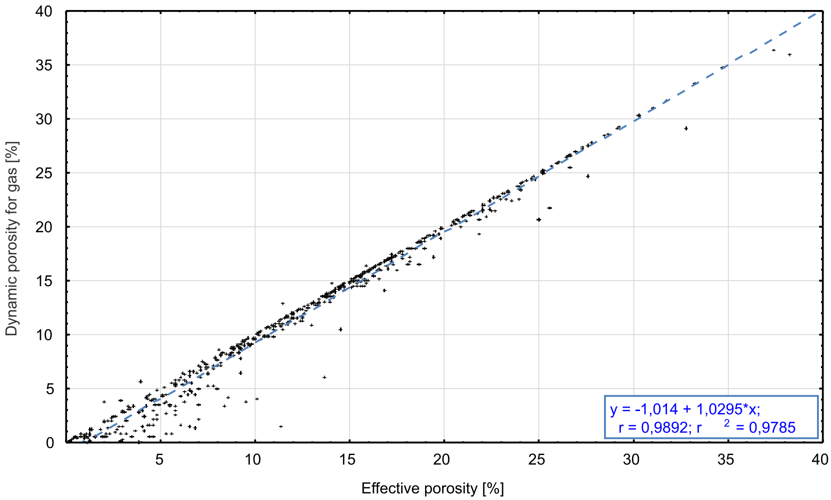

Fig. 8. Chart of the distribution of effective porosity vs. dynamic porosity for gas

However, for the oil the effective porosity values k_e differ significantly from the dynamic porosity ones k_r. In the same wells, e.g. Ciecierzyce-1k and Grotów-1 the values of effective porosity: 20.15 and 14.01%, respectively, correspond to the values of dynamic porosity 12.68% and 9.13, respectively (Tab. 1). Generally, the effective porosity values for the oil K_e = 10% and 20% correspond to the dynamic porosity values K_r = 5% and 13% (Fig. 9).

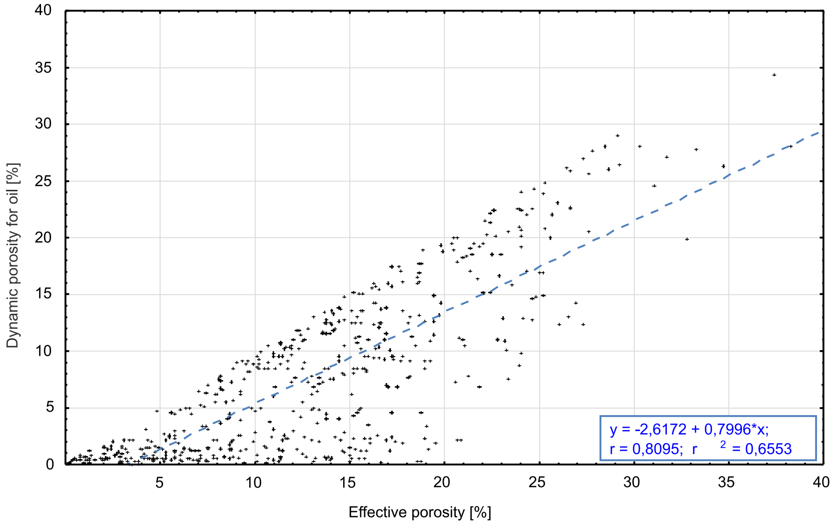

Fig. 9. Chart of the distribution of effective porosity vs. dynamic porosity for oil

The analysis of distribution plots of crucial parameters: effective porosity and dynamic porosity for the oil, and dynamic porosity for the gas accumulated in the Main Dolomite reveal the similar patterns of dynamic porosity of the gas versus dynamic porosity of the oil as well as dynamic porosity for the oil versus effective porosity. Two clusters of results can be observed: one for the Międzychód-4 well for the higher porosity values and second for the Santok-1 well for the lower porosities. The remaining analyzed samples gave roughly linear distribution of the results. The 10% dynamic porosity for the gas corresponds to the 0-10% dynamic porosity for the oil whereas the effective porosity values of 10 and 20% correspond to dynamic porosity for the oil of 0-10% and 0-20%, respectively.

The diagram of dynamic porosity for the gas versus effective porosity reveals the linear dependence of both parameters (Fig. 6). The highest dispersion of points is observed in the Santok-1, Dzierżów-1k bis, Międzychód-4 and Lubiatów-4 wells. The effective porosity values 10% and 20% correspond to the dynamic porosity ones for the gas 10% and 20%, respectively (Fig. 10).

The distribution plots provide information on mutual relationships of parameters and dispersion or agglomeration of points for particular wells (Fig. 8).

The effective and the dynamic porosity for the gas show evident linear dependence and the lowest dispersion of points. The plots of effective and dynamic porosities for the gas and the oil reveal insignificant dispersion of points for low porosity values. The dynamic porosity for the oil shows the lower values in comparison with those for the effective porosity, similarly to the dynamic porosity for the oil related to the dynamic porosity for the gas.

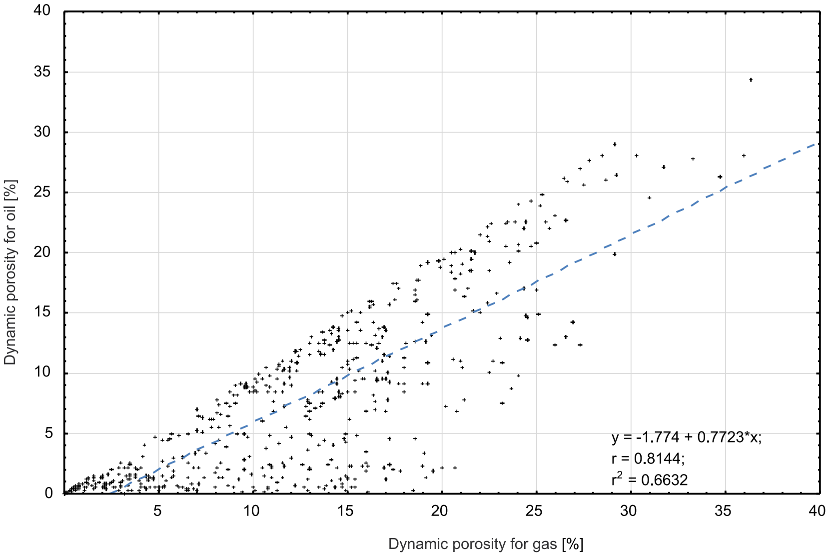

Fig. 10. Chart of the distribution of dynamic porosity for gas vs. dynamic porosity for oil

4. Distribution of effective, dynamic capacity for the gas and the oil in the Main Dolomite

The reservoir capacity of rocks, as a petrophysical parameter, directly identifies the zones of highest hydrocarbon accumulation potential. The distribution maps of the effective reservoir capacity of the Main Dolomite and the dynamic capacity for the gas and for the oil display the total volume of open pores of the reservoir rocks related to the unit area of the reservoir complex $Q\,(m^3/m^2)$.

4.1. Construction of maps of effective reservoir capacity

The set of distribution maps of the effective reservoir capacity within the Main Dolomite was constructed with the application of two algorithms: *Convergent interpolation* and *Kriging interpolation*, both of the Schlumberger's Petrel interpretation system. Unfortunately, the number of input data was rather limited and the distribution of wells over the study area was irregular.

The first stage of maps construction was the verification of the maps of top and bottom surfaces of the Main Dolomite sedimentary series. Because the results of seismic survey were unavailable at this stage of works, the archival structural maps were used. The stratigraphic data from analyzed wells enabled us to verify and to control the archival maps. The errors of depth estimations of particular grids were extrapolated from the measurement sites using the Petrel's *Convergent interpolation* algorithm.

The second stage of maps construction was the drawing of thickness map of the Main Dolomite. The map was prepared with the application of algebraic operations on numerical models. Precisely, the values of altitude coordinates (Z) for the top and the bottom of the Main Dolomite

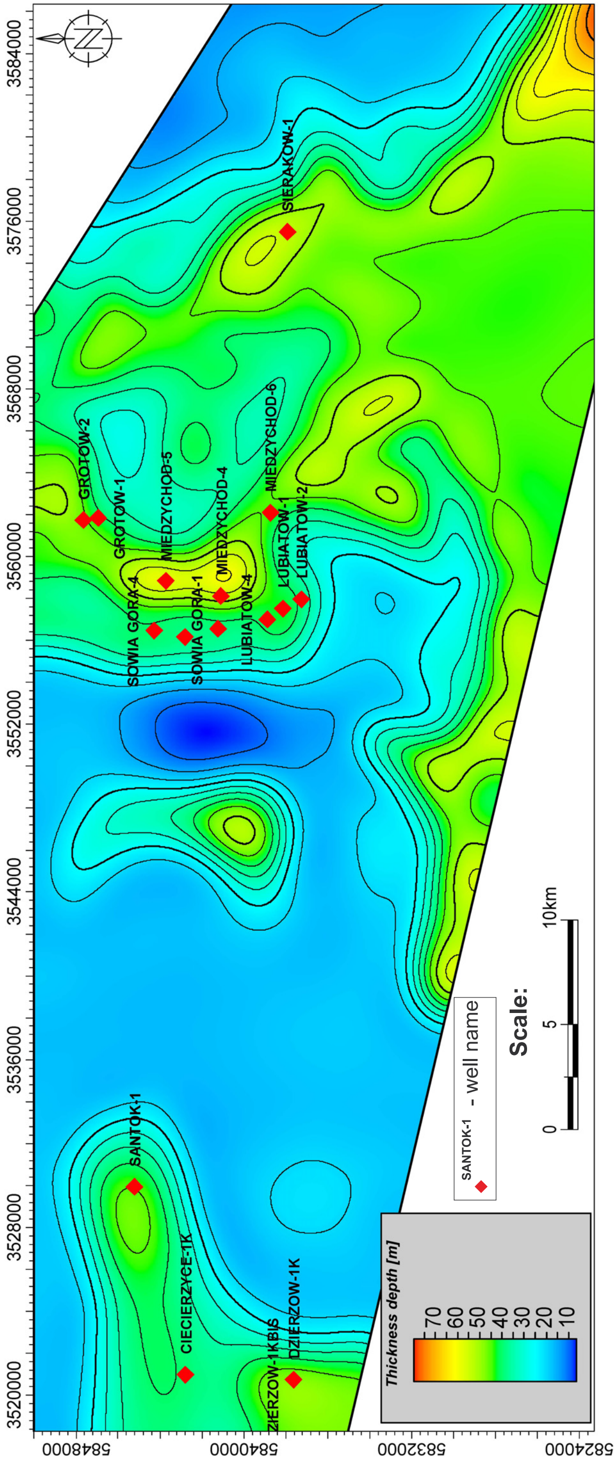

Fig. 11. Map of the thickness of the Main Dolomite in the Gorzów-Pniewy area

were subtracted in the nodes of regular, 100×100 meters interpolation grids (Grid 2d). For maximum reduction of the bias, the matrix filter was applied, which enabled us to obtain the average thickness distribution of the Main Dolomite by elimination of local extreme values (Fig. 11).

In the third stage of maps construction, the interpolation grid of thickness map was multiplied by the interpolation grid of effective porosity map obtained from porosimetric analyses using the superposition method. For this procedure the *Surface Calculator* tool was applied, which allows for arithmetic operations on two-dimensional interpolation grids.

The applied methodology led to the construction of the maps of effective reservoir capacity. Such maps display the volume (in m^3) of free space within the reservoir rock which can be filled with hydrocarbons, related to the area (in m^2) occupied by the reservoir rock within the petroleum basin.

4.2. Areal distribution of effective, dynamic capacity for gas and oil in the Main Dolomite

The set of three maps was prepared, which illustrates the distributions of the effective reservoir capacity in the Main Dolomite and the dynamic capacities for the oil and the gas.

The maps show obvious coincide with the distribution of hydrocarbon deposits in the Main Dolomite. Unfortunately, these maps allow for only preliminary prognosis of petroleum perspectives in the study area due to applied procedures and sparse number of input data. The accuracy of the results is strongly affected by the density of input data. Hence, in the areas distant from the wells, the results are influenced by the interpolation error. On the contrary, in the areas of dense spatial data input, the applied method gives satisfactory results.

Provided that the threshold value of effective storage capacity of the Main Dolomite is $Q = 3.5\ m^3/m^2$, the area of increased effective capacity extends over the southeastern peripheries of the study area, along the boundaries of palaeogeographic zones, starting from the vicinity of Pniewy and continuting northward, through the hydrocarbon deposits of the Lubiatow-Międzychód-Grotów (L-M-G) area until the neighbourhood of Ciecierzyce in the west (Fig. 12).

The local, extreme storage capacity values reach $Q = 10\ m^3/m^2$ in the barrier palaeogeographic zones near Międzychód and Dzierżowa (Międzychód-4 well – 11.99 m^3/m^2 and Dzierżów-1K bis well – 9.02 m^3/m^2) (Tab. 1).

Considering the **storage capacity for gas**, the distribution of its values generally corresponds to the effective capacity of the Main Dolomite. Local decrease is observed northwest of Pniewy and at the southern margin of carbonate platform whereas maximum values occur in the wells: Międzychód-4 ($Q_g = 11.32\ m^3/m^2$) and Dzierżów-1K bis ($Q_g = 6.11\ m^3/m^2$) (Tab. 1, Fig. 13).

The distribution of **storage capacity for oil** in the Main Dolomite reveals more limited potential accumulation areas. These are very local zones where maximum Q_r values were obtained: Lubiatów-1 (8.24 m^3/m^2), Dzierżów-1K bis (6.11 m^3/m^2) and Lubiatów-2 (5.81 m^3/m^2) wells (Tab. 1, Fig. 14).

Taking into account all the discovered hydrocarbon deposits (mostly gas-condensate and gas, subordinately oil) and the observed hydrocarbon manifestations, the potential exploration zones should be related to the areas contoured by the effective capacity value $Q_{ef} > 3\ m^3/m^2$ (Fig. 15), as concluded from both the porosimetric measurements and the thickness distribution of the Main Dolomite. The following zones were identified:

- Pniewy-Sieraków and its northwestern extension, Grotów, Sowia Góra, Dzierżów and Ciecierzyce;

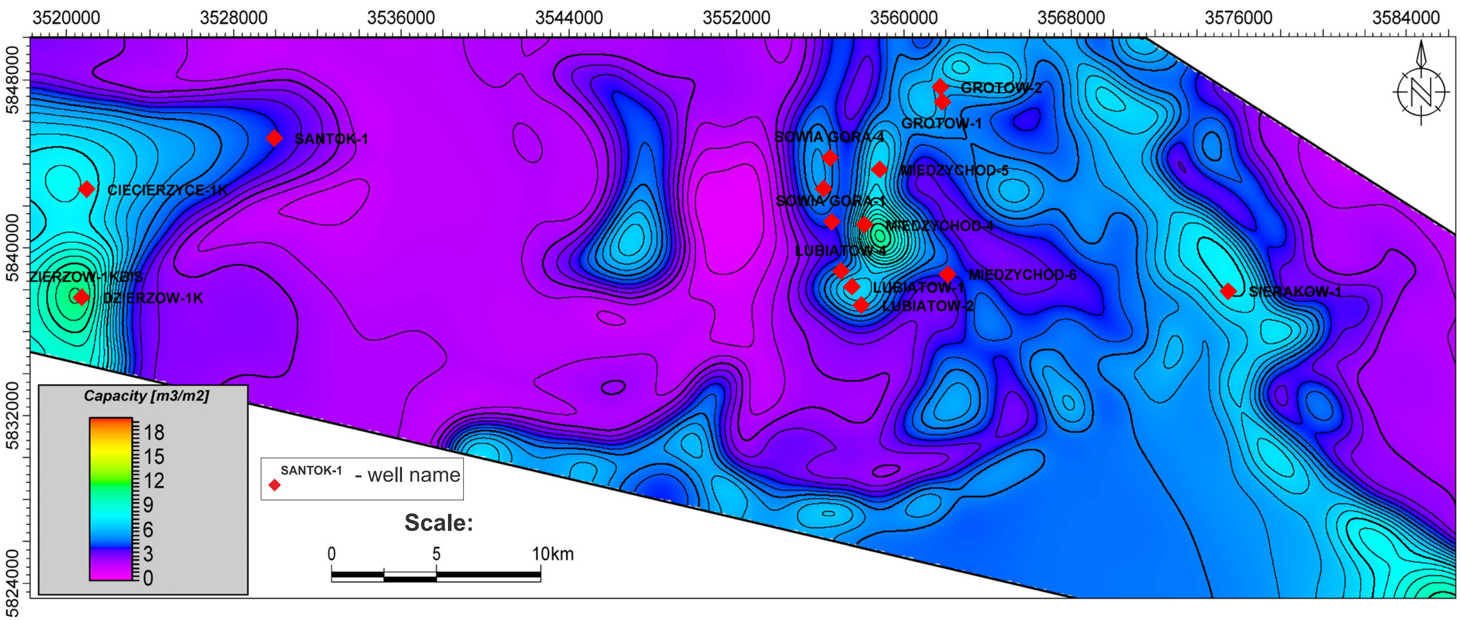

Fig. 12. Map of the trend of the effective capacity (m^3/m^2) of the Main Dolomite in the Gorzów-Pniewy area

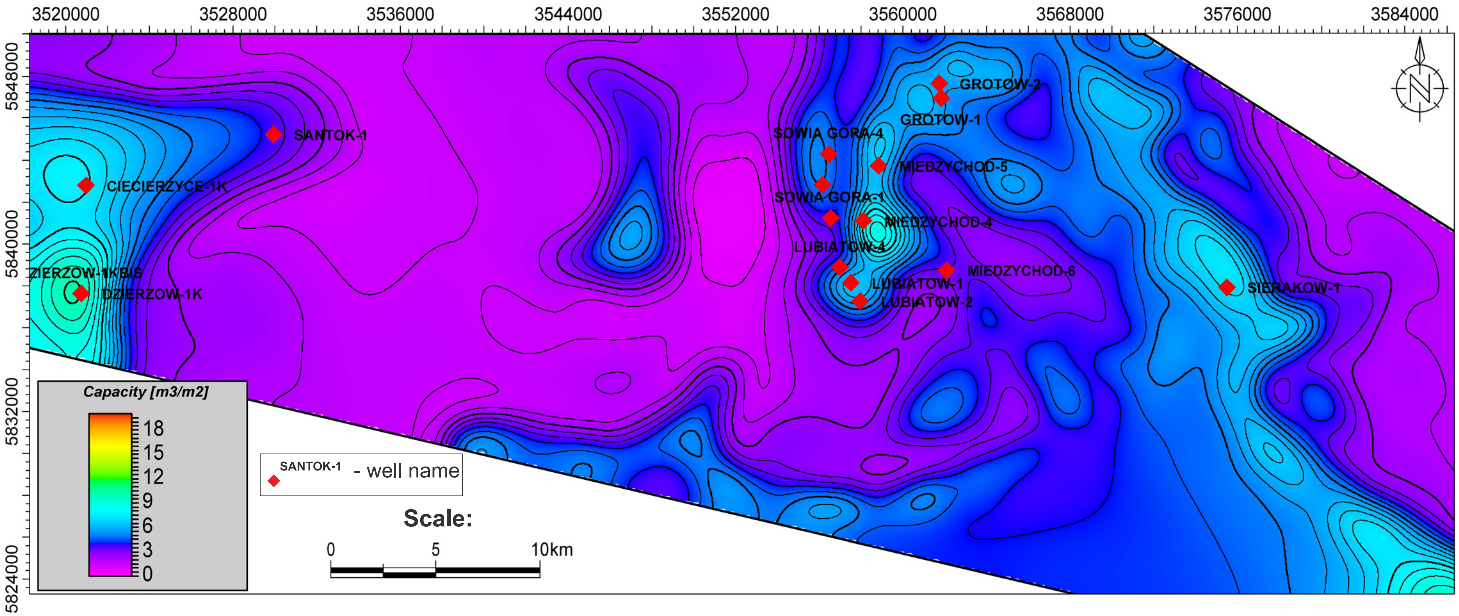

Fig. 13. Map of the trend of the dynamic capacity (m^3/m^2) of the Main Dolomite in the Gorzów-Pniewy area

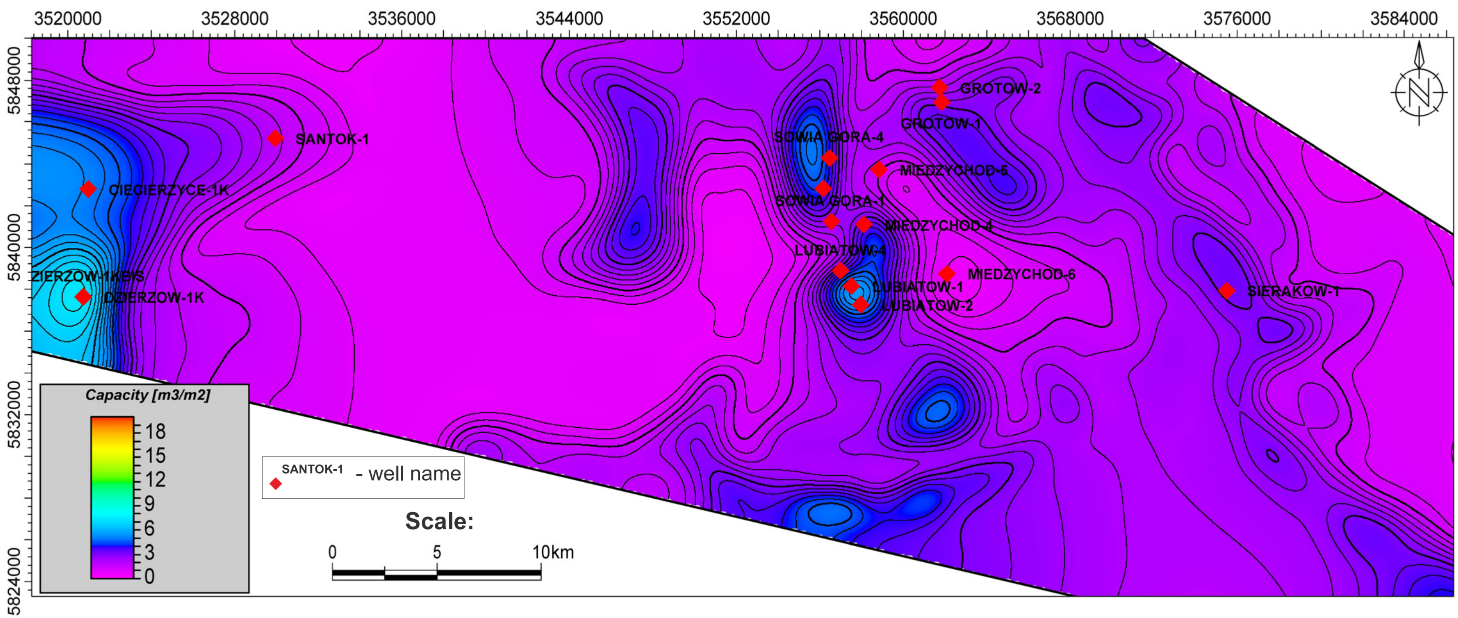

Fig. 14. Map of the trend of the dynamic capacity for oil (m^3/m^2) of the Main Dolomite in the Gorzów-Pniewy area

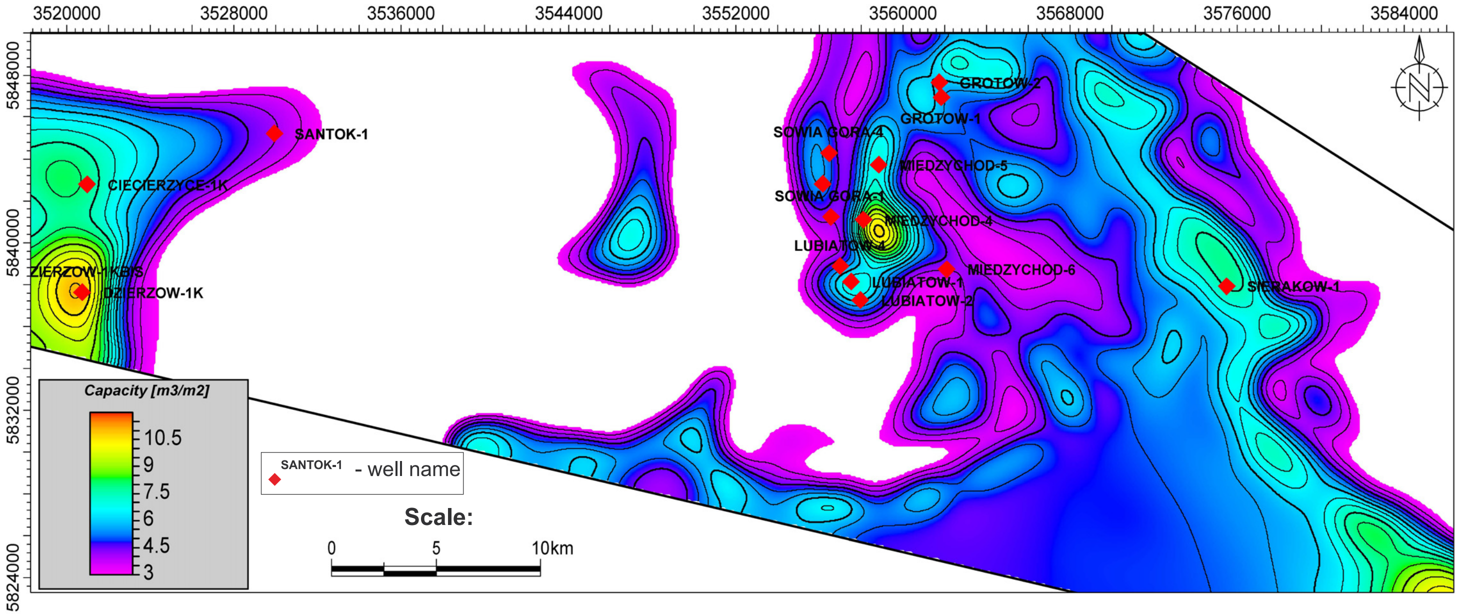

Fig. 15. Map of the trend of the prospective zones (m^3/m^2) of the Main Dolomite in the Gorzów-Pniewy area

- Sowia Góra-Lubiatów-Międzychód-Mokrzec and its parallel extension to the west, through the area of Międzchód-2 well;
- Krobielewko, Dzierżów-Ciecierzyce-Santok – these are local zones of increased storage capacity values in the western part of study area.

5. Summary

As a petrophysical parameter, the reservoir capacity of rocks directly identifies the zones of highest hydrocarbon accumulation potential. The effective capacity of the Main Dolomite reveals distinct zonation determined by dynamic capacities for the oil and for the gas.

Taking into account all discovered hydrocarbon deposits and manifestations (mostly gas-condensate and gas, less commonly oil), the potential petroleum exploration zones should be related to the areas within the contour of $Q_{ef} > 3$ m^3/m^2 value determined from porosimetric measurements and thickness distribution of the Main Dolomite. These are:

- Pniewy-Sieraków area and its northwestern extension, Grotów, Sowia Góra, Dzierżów and Ciecierzyce;
- Sowia Góra-Lubiatów-Międzychód-Mokrzec and its parallel, westerni extension through the Międzchód-2 well;
- Krobielewko, Dzierżów-Ciecierzyce-Santok areas located in the western part of study area, which are local zones of increased storage capacity of the Main Dolomite.

The results of data analysis enabled us to estimate the storage capacity of the Main Dolomite for oil and gas. It may also provide the basis for determination of hydrocarbon balance referred to hydrocarbon generation potential and capacity of the Main Dolomite in the study area.

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