Polish Geological Institute
National Research Institute

Polish Geological Survey
Polish Hydrogeological Survey

HYDROCARBON PROSPECTIVE OF POLAND

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PGI–NRI project No. 22.5004.2101.00.1

GORZÓW WIELKOPOLSKI S
TENDER AREA
GEOLOGICAL PACKAGE ENGLISH ABSTRACT

V LICENSING ROUND
FOR CONCESSIONS FOR HYDROCARBON
PROSPECTION, EXPLORATION AND PRODUCTION
IN POLAND

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for Environmental Protection
and Water Management

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Warsaw, 2021

1. GENERAL INFORMATION
1.1. LOCATION

The “Gorzów Wielkopolski S” tender area of 691.38 km^2 is located onshore in western Poland, in the 183 concession block (Fig. 1.1). The precise location is defined by geographical coordinates listed below.

Border points	1992 coordinate system	
	X	Y
1	549450.19	244711.63
2	546785.65	241113.57
3	540242.75	241894.16
4	540873.53	247572.85
5	546430.59	247861.28
6	547712.18	259199.82
7	540414.53	256580.45
8	531745.15	262931.15
9	531753.26	263057.74
10	521496.05	262559.19
11	521556.67	262436.44
12	521365.66	247695.31
13	528872.38	239725.61
14	528621.24	236900.92
15	527049.18	228863.08
16	540948.98	229635.49
17	547125.25	229978.70
18	550209.91	230150.11
excluding the area defined by points 19–26:		
19	537338.87	235938.86
20	537381.70	235451.89
21	537161.68	235262.61
22	536191.17	234978.91
23	535945.30	236140.79
24	536032.11	236456.84
25	536631.59	236671.44
26	537053.67	236400.94

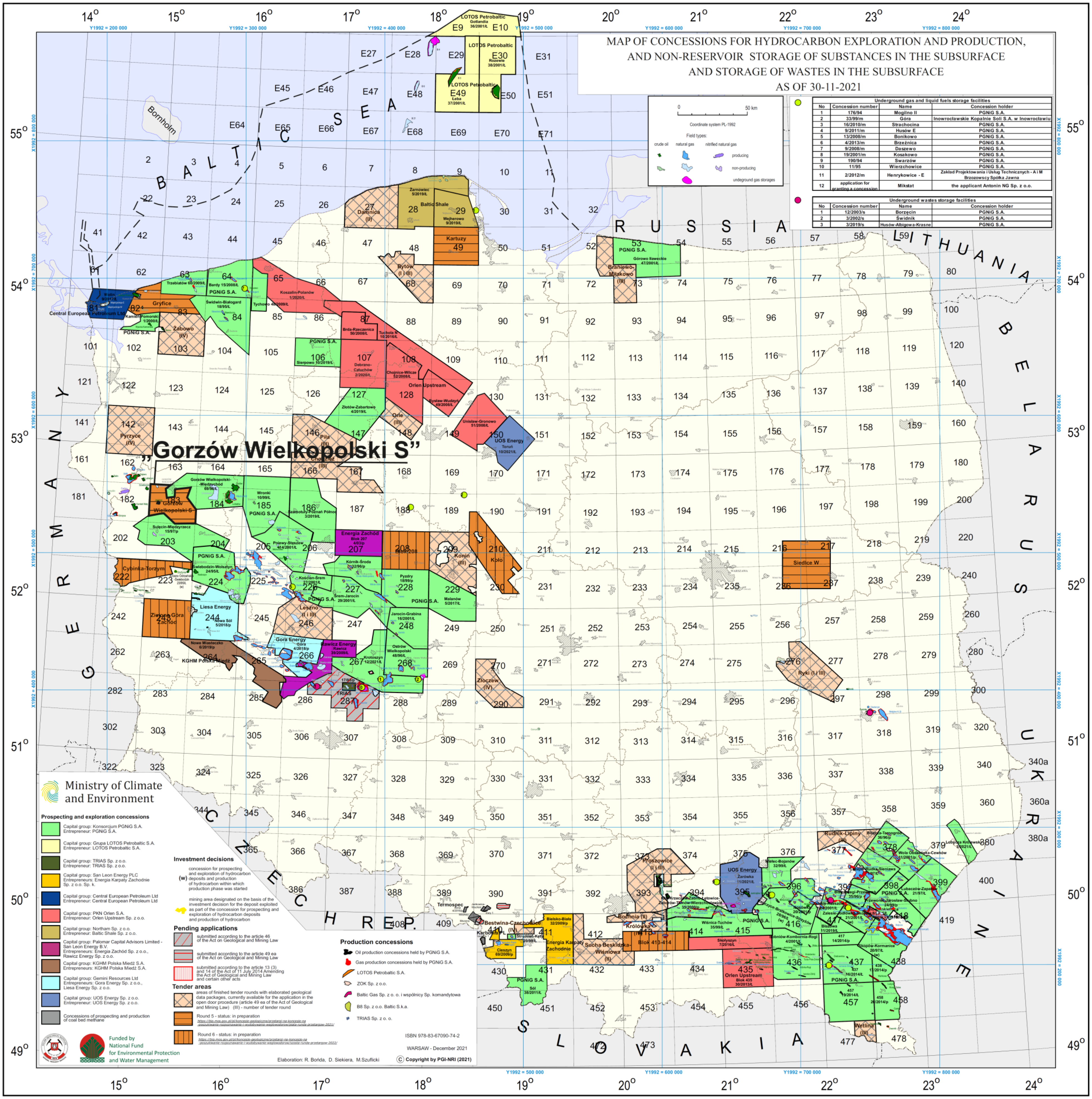
Tab. 1.1. Border points coordinates of the “Gorzów Wielkopolski S” tender area (Fig. 1.2).

The “Gorzów Wielkopolski S” tender area was previously subjected to hydrocarbon prospection and exploration concessions No. 21/95/p Lubniewice, No. 26/99/p Chartów – Ośno Lubuskie, No. 22/95/p Kostrzyń – Myślibórz, and No. 42/2001/p Gorzów Wielkopolski – Myślibórz, operated by PGNiG S.A.

Numerous oil and gas fields have been documented in the neighborhood of the “Gorzów Wielkopolski S” tender area. The most important are Jeniniec, Dzieduszyce, Krobielewko, and Stanowice fields.

The “Gorzów Wielkopolski S” tender area is prospective for conventional oil and gas exploration in the Permian/Zechstein/Main Dolomite.

→**Fig. 1.1.** Location of the “Gorzów Wielkopolski S” tender area on the map of concessions for hydrocarbon exploration and production, and non-reservoir storage of substances in the subsurface and storage of wastes in the subsurface as of 30-11-2021.


MAP OF CONCESSIONS FOR HYDROCARBON EXPLORATION AND PRODUCTION,
AND NON-RESERVOIR STORAGE OF SUBSTANCES IN THE SUBSURFACE
AND STORAGE OF WASTES IN THE SUBSURFACE
AS OF 30-11-2021
„Gorzów Wielkopolski S"
Ministry of Climate and Environment
Prospecting and exploration concessions
Investment decisions
Pending applications
Tender areas
Production concessions
Underground gas and liquid fuels storage facilities
Underground wastes storage facilities
B A L T I C   S E A
R U S S I A
L I T H U A N I A
B E L A R U S
U K R A I N E
S L O V A K I A
C Z E C H   R E P.
G E R M A N Y
Bornholm
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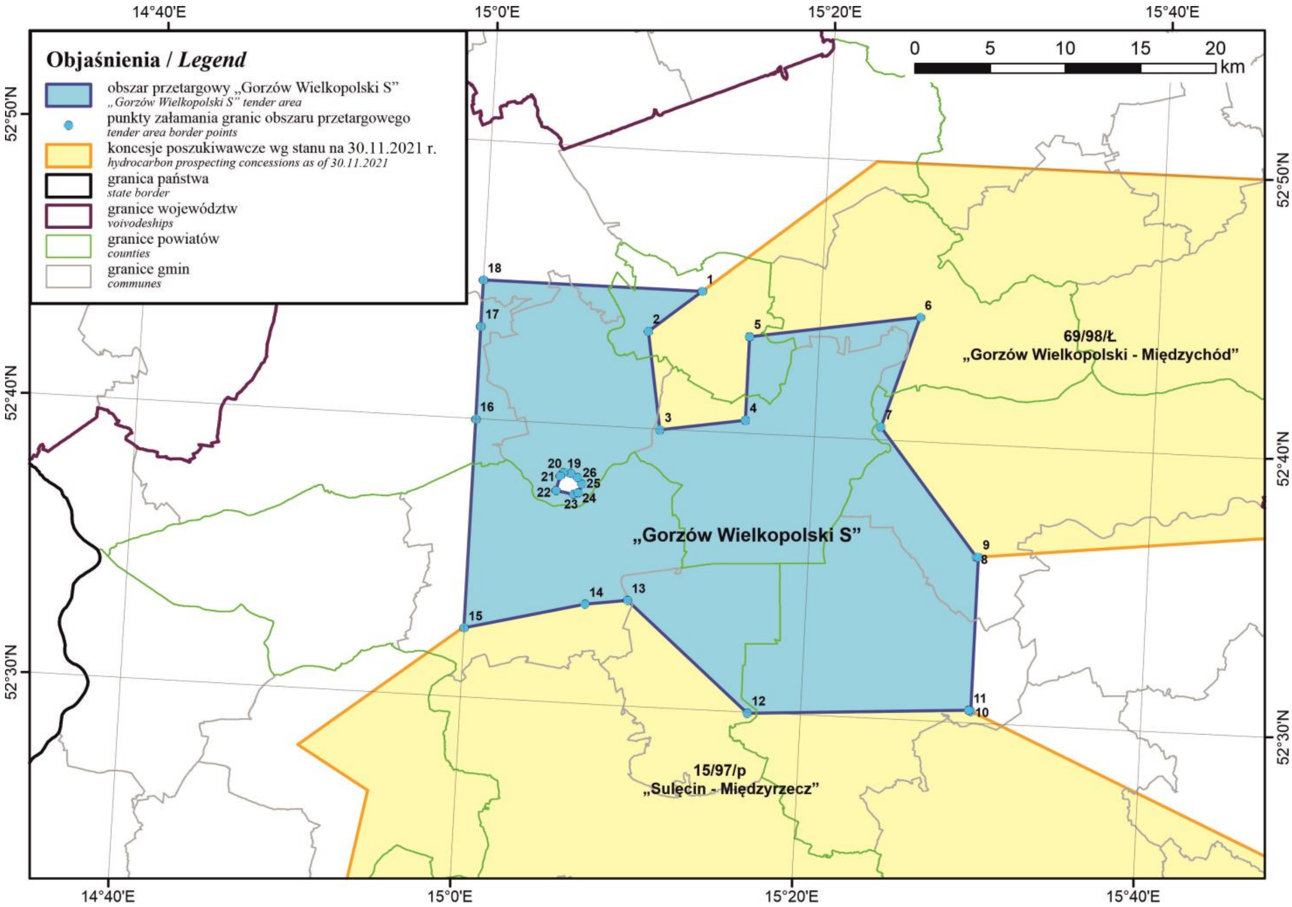


Fig. 1.2. Border points of the "Gorzów Wielkopolski S" tender area and location of the hydrocarbon concessions in the neighborhood as of 30-11-2021 (CGDB, 2021).

1.2. ENVIRONMENTAL CONDITIONS

The “Gorzów Wielkopolski S” tender area is located in the Lubuskie Voivodeship and covers 9 communes, including the important, industrial in nature, municipal center of Gorzów Wielkopolski, inhabited by over 120 thousand of people. The area has a well-developed road network, consisting of international, as well national roads, such as the S3 expressway (being part of the international E65 route), national roads (DK 22 and 24) and provincial, county and municipal roads. The road infrastructure is complemented by 2 non-electrified railway lines.

The “Gorzów Wielkopolski S” tender area is located in 5 physiogeographic mesoregions of Poland, with the Gorzów Basin and Łagowskie Lakeland being the dominant ones. The remaining are Poznań Lakeland, Gorzów Plain and Zbąszyńska Furrow. The entire area is located in the second-order Warta catchment area, which belongs to the Odra River Basin.

There are 6 nature reserves on the tender area covering a total of 0.8% of its surface. The Warta Mouth Landscape Riverside Park and the buffer zone of the Warta Mouth National Park cover 1% of the tender area. Protected landscape and Natura 2000 areas have a much wider range and cover respectively 33% and 14.5% of the surface. Moreover, in the described region there are 26 ecological areas and 44 objects selected as natural monuments. In addition, the areas of agricultural land of high valuation classes in the southern and south-eastern part and dense forest complexes, which are often covered by the mentioned above forms of nature protection, are also valuable in terms of nature protection. There are 22 mineral deposits in the “Gorzów Wielkopolski S” tender area, including 21 natural aggregate deposits, and 1 gas deposit. Moreover, a dozen prospective areas of sand and sand and gravel have been specified, as well as 1 prognostic area for peat.

The environmental conditions for the “Gorzów Wielkopolski S” tender area are summarized in Tab. 1.2.

THE ENVIRONMENTAL CONDITIONS DATASHEET FOR THE "GORZÓW WIELKOPOLSKI S" TENDER AREA				
1.	LOCATION OF THE TENDER AREA ON THE MAP	Name and number of the map sheet at a scale 1: 50 000	Gorzów Wielkopolski 387, Santok (Górki) 388, Krzeszyce (Lubniewice) 426, Bledzew 427	
2.	ADMINISTRATIVE LOCATION	**Voivodeship**	**lubuskie**	
		County	**Gorzów Wielkopolski City**	
		The commune and % of the area within the tendering area	Gorzów Wielkopolski (3.71%)	
		County	**Gorzów Wielkopolski**	
		Commune	Lubiszyn (1.61%), Witnica (2.81%), Bogdaniec (15.46%), Deszczno (22.28%), Santok (1.73%)	
		County	**Sulęcin**	
		Commune	Krzeszyce (16.69%), Lubniewice (8.45%)	
		County	**Międzyrzecz**	
		Commune	Skwierzyna (6.68%), Bledzew (20.58%)	
3.	PHYSIOGRAPHIC REGIONALIZATION (after KONDRACKI, 2013 and SOLON et al., 2018)	Macroregion	Southern Pomerania Lakeland (314.6-7)	
		Mesoregion	Gorzów Plain (314.61)	
		Macroregion	Toruń-Eberswalde Ice Marginal Valley (315.3)	
		Mesoregion	Gorzów Basin (315.33)	
		Macroregion	Lubskie Lakeland (315.4)	
		Mesoregion	Łagów Lakeland (315.42), Zbąszynek Basin (315.44)	
		Macroregion	Wielkopolskie Lakeland (315.5)	
		Mesoregion	Poznań Lakeland (315.51)	
4.	COORDINATES OF THE TENDER AREA BORDER POINTS	PL-1992 coordinate system	549450,19	244711,63
			546785,65	241113,57
			540242,75	241894,16
			540873,53	247572,85
			546430,59	247861,28
			547712,18	259199,82
			540414,53	256580,45
			531745,15	262931,15
			531753,26	263057,74
			521496,05	262559,19
			521556,67	262436,44
			521365,66	247695,31
			528872,38	239725,61
			528621,24	236900,92
			527049,18	228863,08
			540948,98	229635,49
			547125,25	229978,70
			550209,91	230150,11
			excluding the area defined by points:	
			537338,87	235938,86
			537381,70	235451,89
			537161,68	235262,61
			536191,17	234978,91
			535945,30	236140,79
			536032,11	236456,84
			536631,59	236671,44
			537053,67	236400,94
5.	ACREAGE	[km^2]	691.38	
6.	CONCESSION TYPE		prospecting, exploration and production of hydrocarbons	
7.	TARGET		Permian/Zechstein/Main Dolomite	

THE ENVIRONMENTAL CONDITIONS DATASHEET FOR THE "GORZÓW WIELKOPOLSKI S" TENDER AREA			
8.	PROTECTED NATURAL AREAS:	[yes/ no] if "yes": the name of the tender area and its % area within the area	
	National Parks		no
	Natural Reserves		Bogdanieckie Grądy (<1%), Dębowa Góra (<1%), Gorzowskie Murawy (<1%), Janie im. Włodzimierza Korsaka (<1%), Morenowy Las (<1%), Santockie Zakole (<1%);
	Landscape Parks		PK Ujście Warty (<1%)
	Protected landscape areas		OChK Lasy Witnicko-Dzieduszyckie (<1%), OChK Dolina Obry (4%), OChK Dolina Warty i Dolnej Noteci (6%), OChK Gorzowsko-Krzeszycka Dolina Warty (17%), OChK Pojezierze Lubniewicko-Sulęcińskie (5%), OChK Dolina Postomii (<1%)
	Natura 2000, (Special Area of Conservation, SAC)		PLH080006 Ujście Noteci (3%), PLH080058 Murawy Gorzowskie (<1%)
	Natura 2000, (Special Bird Protection, SPA)		PLB320015 Ostoja Witnicko-Dębniańska (6%), PLB300015 Puszcza Notecka (<1%), PLB080002 Dolina Dolnej Noteci (3%)
	Natura 2000, (SAC+SPA)		PLC080001 Ujście Warty (5%)
	Nature and landscape complexes		Kijewickie Kierki (1%);
	Ecological area	[yes (quantity) / no]	26
	Nature monuments		44
	Documentation positions		no
9.	PROTECTED SOIL	[Yes No]	yes
10.	FOREST COMPLEXES	[Yes No]	yes
11.	PROTECTIVE FORESTS	[yes (area % of the area within the tender area) / no]	129.7 km^2 (18.8%)
12.	CULTURAL HERITAGE FACILITIES Archaeological monuments	[yes (quantity) / no]	
		Hillfort	1
		Hamlet	3
		Cemetery	no
		others	no
13.	MAJOR GROUNDWATER RESERVOIRS	[yes (number, name and age of the aquifer) / no]	138 Toruń Eberswalde Urstromtal; Q
14.	PROTECTIVE ZONES OF WATER INTAKE	[yes / no]	yes
15.	SPA PROTECTION ZONES	[yes / no]	no
16.	FLOOD HAZARD AREA	[yes / no]	yes
17.	PROVEN MINERAL DEPOSITS	[yes (type of mineral deposit) / no]	yes (natural aggregates, natural gas)
18.	PROGNOSTIC AND PROSPECTIVE AREAS OF OCCURRENCE OF MINERAL RESOURCES (excluding hydrocarbons)	[yes (type of mineral deposit)/ no]	yes (sand, sand and gravel, peat)
19.	NATURAL GAS PIPELINES	[yes / no]	yes
20.	UNDERGROUND GAS STORAGE	[yes / no]	no
21.	DATE OF THE DATASHEET COMPLETION	26.02.2021	
22.	DATA COLLECTION AND ELABORATION	Paulina Kostrz-Sikora, Dominika Kafara	

Tab. 1.2. The environmental conditions datasheet for the "Gorzów Wielkopolski S" tender area.

→**Fig. 1.3.** Environmental map of the "Gorzów Wielkopolski S" tender area.

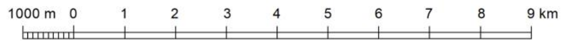
PAŃSTWOWY INSTYTUT GEOLOGICZNY
PAŃSTWOWY INSTYTUT BADAWCZY
PSG
PAŃSTWOWA SŁUŻBA GEOLOGICZNA

Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej

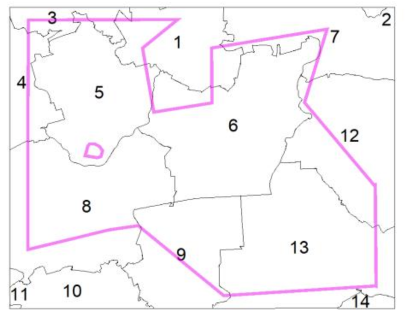
Ministerstwo Klimatu i Środowiska

Mapa środowiskowa obszaru "GORZÓW WIELKOPOLSKI S"

Environmental Map of the "GORZÓW WIELKOPOLSKI S" area

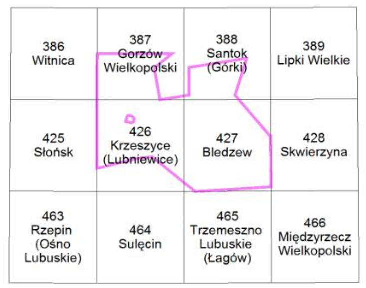


Położenie obszaru przetargowego na tle podziału administracyjnego
Location of tender area on administrative division map



woj. LUBUSKIE
powiat Gorzów Wielkopolski
1 - m. Gorzów Wielkopolski
powiat strzelecko-drezdenecki
2 - gm. Zwierzyn
powiat gorzowski
3 - gm. Lubiszyn
4 - gm. Witnica
5 - gm. Bogdaniec
6 - gm. Deszczno
7 - gm. Santok
powiat sulęciński
8 - gm. Krzeszyce
9 - gm. Lubniewice
10 - gm. Sulęcin
powiat słubicki
11 - gm. Ośno Lubuskie
powiat międzyrzecki
12 - gm. Skwierzyna
13 - gm. Bledzew
14 - gm. Międzyrzecz

Położenie obszaru przetargowego na arkuszach 1:50 000
Location of tender area on maps with a scale of 1:50 000



Zestawienie danych oraz redakcja komputerowa mapy: *Dominika Kafara*
Data compilation and map edition:

Weryfikacja: *Anna Gabryś-Godlewska*
Verification:

Objaśnienia do mapy środowiskowej obszaru "GORZÓW WIELKOPOLSKI S"

Legend of the environmental map of the "GORZÓW WIELKOPOLSKI S" area

(opracowano na podstawie bazy MGśP z zasobów PIG-PIB)*

(based on MGśP database)*

ZŁOŻA KOPALIN ORAZ PERSPEKTYWY I PROGNOZY ICH WYSTĘPOWANIA

MINERAL DEPOSIT AND PERSPECTIVE AREA'S, PROGNOSTIC AREA'S FOR DOCUMENTING DEPOSITS

- piaski i żwiry – sands and gravels
- iły i łupki ilaste – raw materials
- piaski – sands
- torfy – peat
- 2914 – identyfikator z bazy MIDAS złoża małokonfliktowego – ID from the MIDAS database of the small environmental conflict
- 4572 – identyfikator z bazy MIDAS złoża konfliktowego – ID from the MIDAS database of the environmental conflict
- granica złoża – deposit boundary
- granica obszaru prognostycznego – prognostic area boundary
- granica obszaru perspektywicznego – perspective area boundary
- złoże o powierzchni ⩽ 5 ha – deposit with area ⩽ 5 ha

GÓRNICTWO I PRZETWÓRSTWO KOPALIN

MINING AND MINERAL PROCESSING

- granica obszaru górniczego – boundary of the mining area
- granica terenu górniczego – boundary of the mining terrain
- obszar i teren górniczy złoża o powierzchni ⩽ 5 ha – area and terrain of the deposit with area ⩽ 5 ha
- p – punkt niekoncesjonowanej eksploatacji kopaliny (p - rodzaj kopaliny) – point of unlicensed exploitation of a mineral (p - type of mineral)

Symbol kopaliny:
Mineral symbol:

- G - gaz ziemny – natural gas
- R - ropa naftowa – crude oil
- i(ic) - iły i łupki ilaste ceramiki budowlanej – building ceramics raw materials
- pż - piaski i żwiry – sands and gravels
- p - piaski – sands
- t - torfy – peat

Symbol jednostki stratygraficznej:
Symbol of the stratigraphic unit:

- Q - Czwartorzęd – Quaternary
- Ng - Neogen – Neogene
- Pg - Paleogen – Paleogene
- P - Perm – Permian

WODY POWIERZCHNIOWE I PODZIEMNE

SURFACE AND UNDERGROUNG WATERS

- obszary dolinne zagrożone podtopieniami – valley flood hazard area
- granica działu wodnego drugiego rzędu – water divide of second rank
- granica działu wodnego trzeciego rzędu – water divide of third rank
- granica działu wodnego czwartego rzędu – water divide of fourth rank
- 138 – granica głównego zbiornika wód podziemnych wraz z jego numerem – principle boundary aquifer with ID number
- granica strefy ochrony ujęcia wód – water intake protected area boundary
- Q – granica leja depresyjnego wywołanego eksploatacją wód podziemnych (Q - wiek eksploatowanych utworów) – boundary of a cone depression caused by water exploitation (Q - age of exploited rocks)
- źródło – spring
- Zb. Bledzew – zbiornik retencyjny wraz z jego nazwą – water reservoir with its name
- k Q – ujęcie wód podziemnych o wydajności ⩾ 50 m³/h (k - komunalne, p - przemysłowe, Q - wiek ujmowanych utworów) – underground water intake with capacity ⩾ 50 m³/h (k - municipal, p - industrial, Q - age of exploited rocks)

OCHRONA PRZYRODY, KRAJOBRAZU I DZIEDZICTWA KULTUROWEGO

PROTECTION OF NATURE, LANDSCAPE AND CULTURAL HERITAGE

- grunty orne (klasy I-IVa użytków rolnych) – arable land (class I-IVa)
- łąki na glebach pochodzenia organicznego – meadows on organic soils
- lasy – forests
- lasy ochronne – protected forests
- zieleń urządzona – urban greenery
- granice terenów zarządzanych przez Dyrekcję Generalną Lasów Państwowych – boundary of areas managed by General Directorate of the State Forests
- granica strefy ochronnej (otuliny) parku narodowego – boundary of buffer zone of national park
- granica parku krajobrazowego; nazwa parku – boundary of landscape park; park name
- granica obszaru chronionego krajobrazu; nazwa obszaru – boundary of protected landscape area; area name
- granica zespołu przyrodniczo-krajobrazowego, nazwa zespołu – boundary of nature and landscape complex; complex name
- St – granica rezerwatu przyrody (St - stepowy, Fn - faunistyczny, L - leśny, W - wodny) – boundary of natural reserve (St - steppe, Fn - faunistic, L - forests, W - water)
- granica strefy ochronnej (otuliny) rezerwatu przyrody – boundary of buffer zone of natural reserve
- Obszary Europejskiej Sieci Ekologicznej Natura 2000; kod obszaru – Natura 2000 ecological network; area code
- aleja drzew pomnikowych – avenue of monumental trees
- Obszary Europejskiej Sieci Ekologicznej Natura 2000 o powierzchni ⩽ 5 ha; kod obszaru – Natura 2000 ecological network with area ⩽ 5ha; area code
- n – pomnik przyrody żywej (n - liczba obiektów) – animate nature monument (n - numer of objects)
- pomnik przyrody nieożywionej – inanimate nature monument
- użytek ekologiczny – ecological area
- n – użytek ekologiczny o powierzchni ⩽ 5 ha (n - liczba obiektów) – ecological area with area ⩽ 5 ha (n - number of objects)
- geostanowisko o znaczeniu krajowym – geosite of national importance
- głaz narzutowy o średnicy >1,5 m niezakwalifikowany jako pomnik przyrody – glacial erratic less than 1.5m in diameter, not qualified as natural monument
- stanowisko archeologiczne – archeological site

INFORMACJE DODATKOWE

ADDITIONAL INFORMATIONS

- granica powiatu – district boundary
- granica gminy, miasta – commune or town boundary
- S3 – oś autostrady lub drogi szybkiego ruchu – highway or express route
- BOGDANIEC – siedziba urzędu gminy, miasta – commune or town office headquarter
- sieć gazociągów przesyłowych – natural gas pipeline network
- sieć elektroenergetyczna najwyższych napięć – high-voltage power network
- granica obszaru przetargowego – boundary of tender area

* *Wykorzystano informacje udostępniane przez: RZGW, GDOŚ, GDLP, IMGW-PIB, NID, PSE, GAZ-SYSTEM, urzędy morskie oraz z baz danych PSG i PSH w PIG-PIB*

* *Data source: RZGW, GDOŚ, GDLP, IMGW-PIB, NID, PSE, GAZ-SYSTEM, maritime offices and from database of PSG and PSH*

2. GEOLOGY

2.1. GENERAL GEOLOGY AND TECTONICS

The stratigraphic succession of the "Gorzów Wielkopolski S" tender area is divided into three units: Variscan West European (Paleozoic) Platform, Laramide Permian-Mesozoic sedimentary succession and Cenozoic cover (Żelaźniewicz et al., 2011; Nawrocki and Becker, 2017; Figs 2.1–2.11). The area is located N from the Dolsk fault zone, on the Brandenburg-Wolsztyn High (Kiersnowski et al., 2010; Figs 2.3–2.4). The High is built of isolated ridges and trenches, which are part of the post-Variscan dextral strike-slip fault zone, related probably to the Dolsk Fault. The Variscan top surface occurs at depths between 3500–4000 m b.s.l. (Kudrewicz, 2008; Fig. 2.5).

Above the strongly folded Carboniferous and older rocks (see Mazur et al., 2003), the Permian-Mesozoic cover occurs. At its base, with angular unconformity, volcanic rocks of the Lower Rotliegend (up to 500 m thick) occur, originated as an effect of post-Variscan extension and opening of the German-Polish Permian Basin (Kiersnowski and Buniak, 2006; Fig. 2.6). The Zechstein basement surface occurs at depths between 3100–3400 m b.s.l. (Kudrewicz, 2008; Fig. 2.7). This Upper Permian succession achieved originally over 800 m thickness (Wagner et al., 2008; Fig. 2.8). The Triassic, Jurassic and Cretaceous deposits, dipping monoclinally to the NE, form the Zechstein overburden (Figs 2.9–2.11). These strata were subjected to halokinetic synsedimentary deformation that started in the Late Triassic (Czekański et al., 2010; compare to Dadlez et al., 1998a,b – Fig. 2.10). In terms of sub-Cenozoic regional geology, the "Gorzów Wielkopolski S" tender area is located in the western part of the Szczecin-Miechów Synclinorium, on the so-called Gorzów Block (Dadlez, 1974; Narkiewicz and Dadlez, 2008; Karnkowski, 2010; Figs 2.4–2.6).

The stratigraphy and lithology of the particular part of sedimentary succession was recognized in several boreholes located in the "Gorzów Wielkopolski S" tender area and its close neighborhood. These are: Baczyna 1, 2, Brzozowa 1, Ciecierzyce 1, 1K, Dzierżów 1K, 1K-BIS, Jeniniec 4, Jeżyki 1, Lubno 1, Maszków 1, Płonica 1, Racław 1K, Stanowice 1, 2, 3, Wędrzyn 1, 5. Their location can be found in Fig. 5.1.

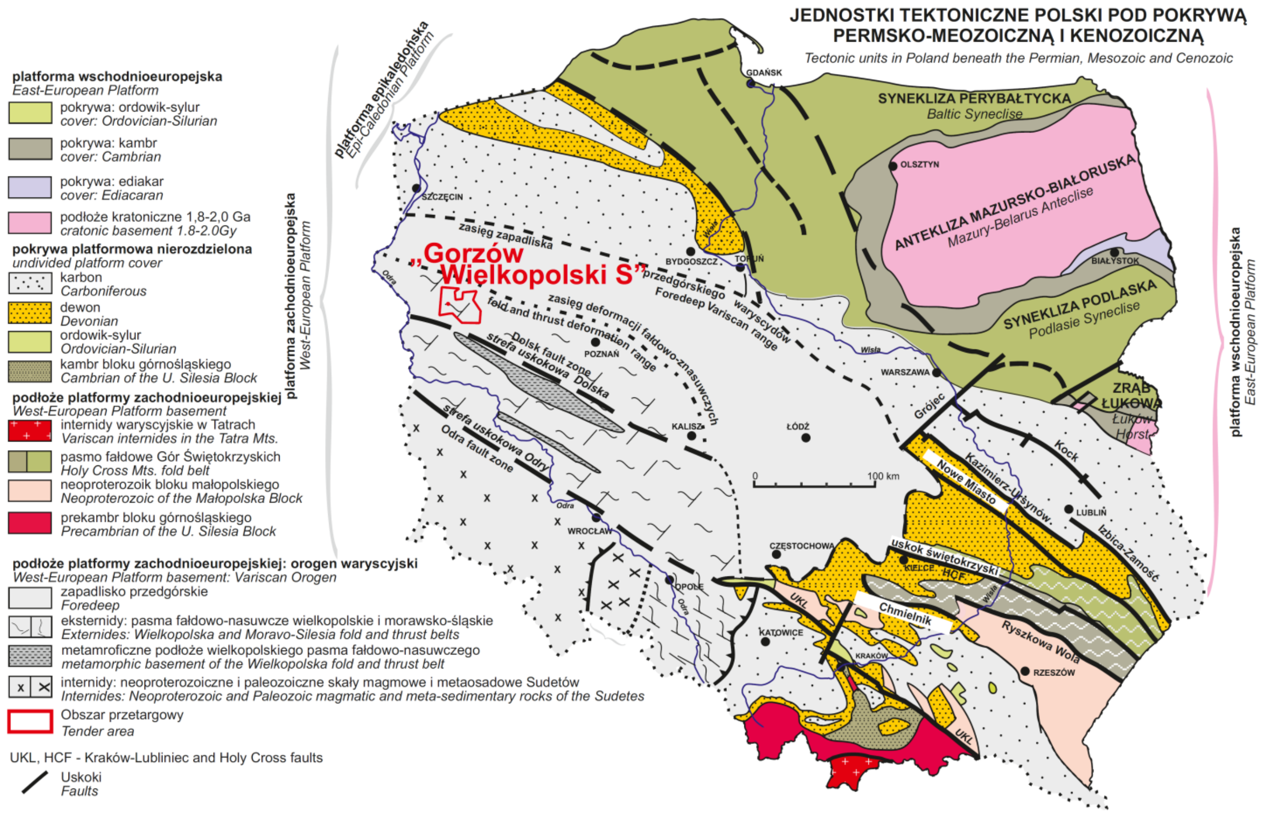


Fig. 2.1. Location of the "Gorzów Wielkopolski S" tender area in relation to the main tectonic units in Poland beneath the Permian, Mesozoic and Cenozoic (Żelaźniewicz et al., 2011).

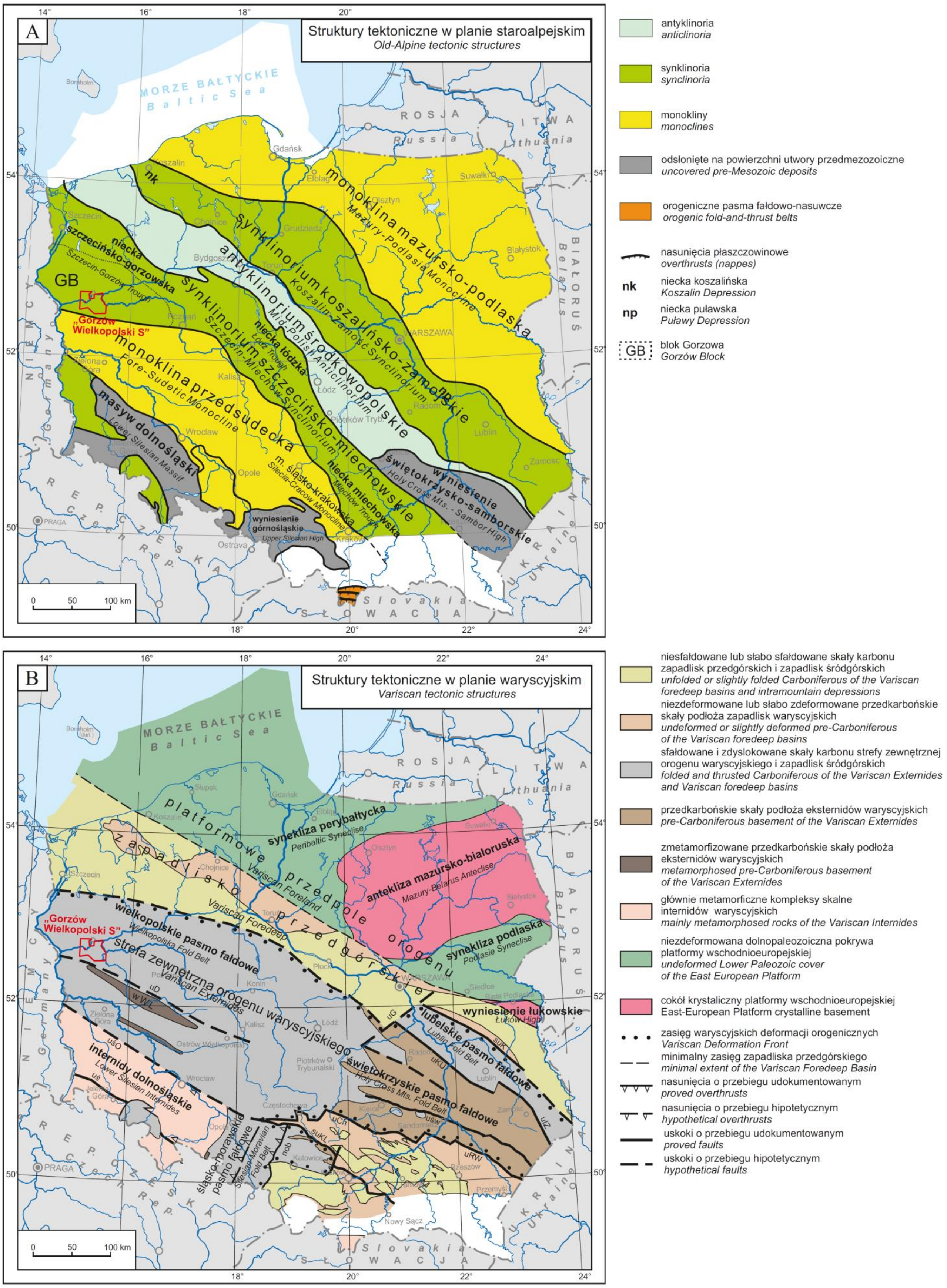


Fig. 2.2. A. Location of the "Gorzów Wielkopolski S" tender area in relation to the Old-Apline tectonic structures on the Polish Lowland (Nawrocki and Becker, 2017). B. Location of the Gorzów Wielkopolski S tender area in relation to the Variscan tectonic structures on the Polish Lowland (Nawrocki and Becker, 2017).

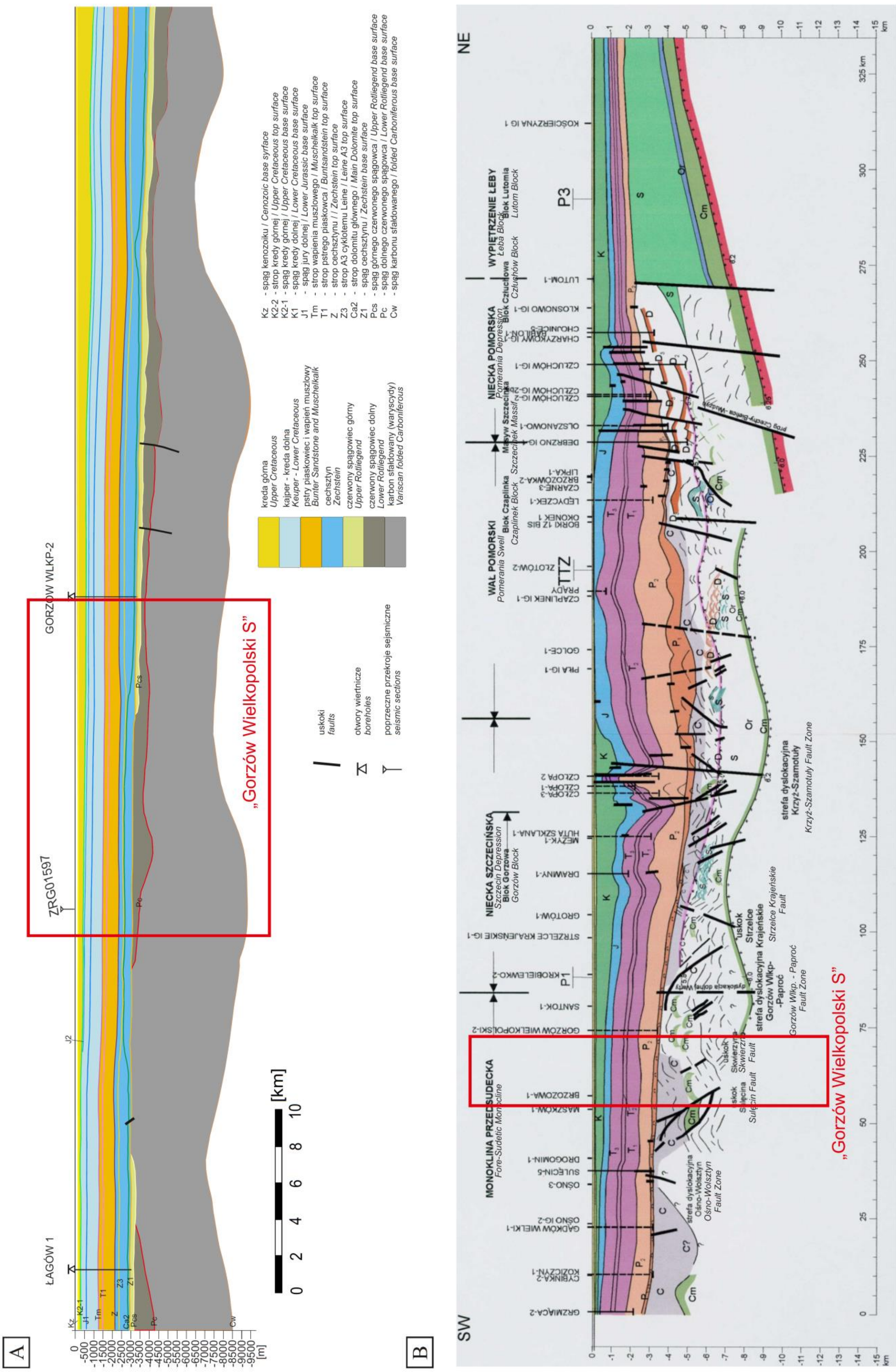


Fig. 2.3. A. Regional geological cross-section along integrated ZRG00697 seismic line (Wagner et al., 2008, modified). **B**. Geophysical-geological interpretation of the BMT-5 section (Stefaniuk et al., 2008; modified).Red squares indicate the range of the “Gorzów Wielkopolski S” tender area. Location of cross-sections can be found in Figs 2.9–2.11.

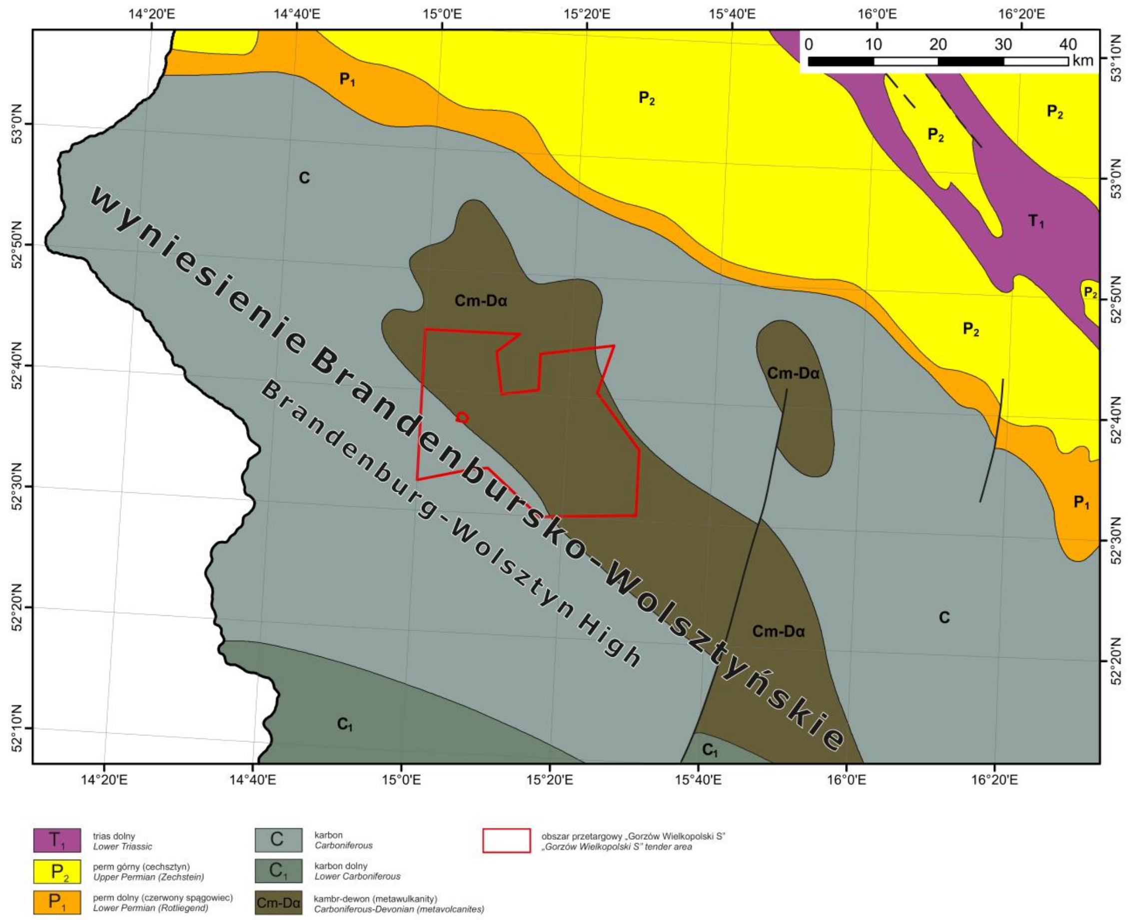


Fig. 2.4. Location of the "Gorzów Wielkopolski S" tender area on the map of horizontal cutting at 4000 m b.s.l. (Kotański, 1997; modified).

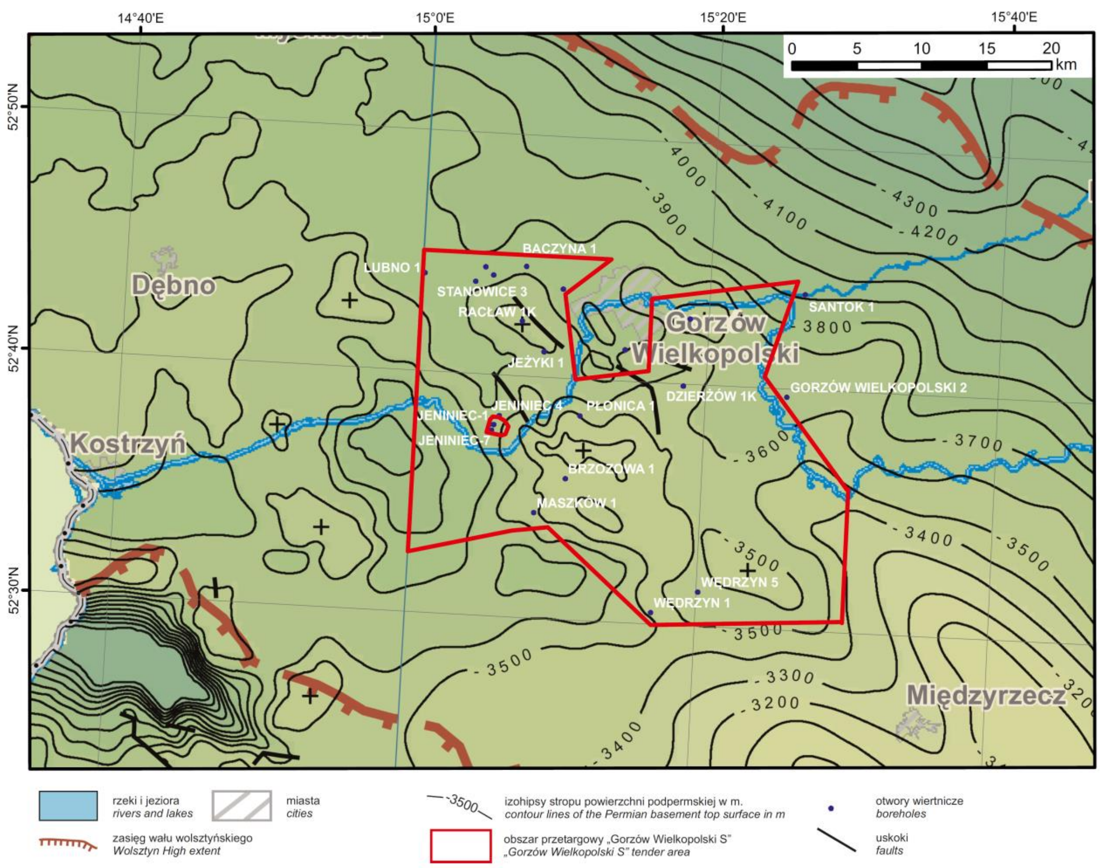


Fig. 2.5. Location of the "Gorzów Wielkopolski S" tender area on the structural map of the Permian basement top surface (Kudrewicz, 2008; modified).

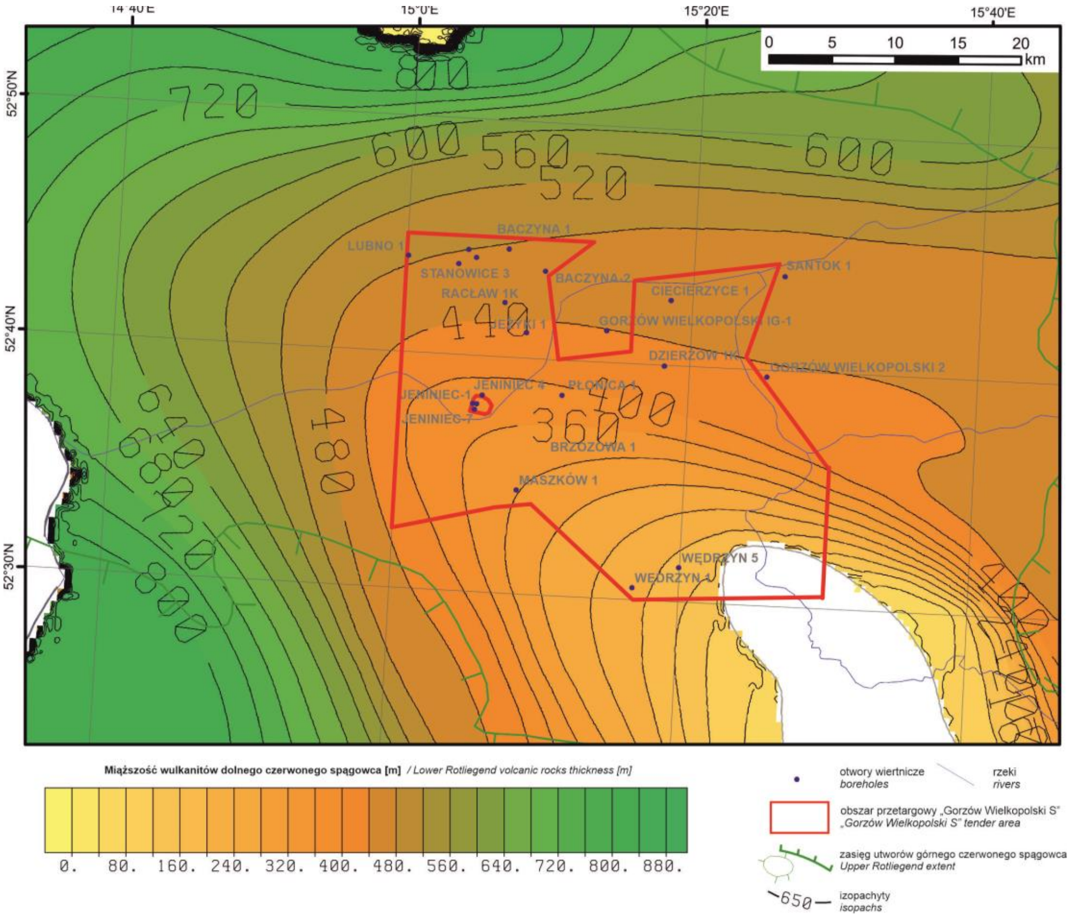


Fig. 2.6. Location of the "Gorzów Wielkopolski S" tender area on the map of the Lower Rotliegend volcanic rock thickness (Wagner et al., 2008; modified).

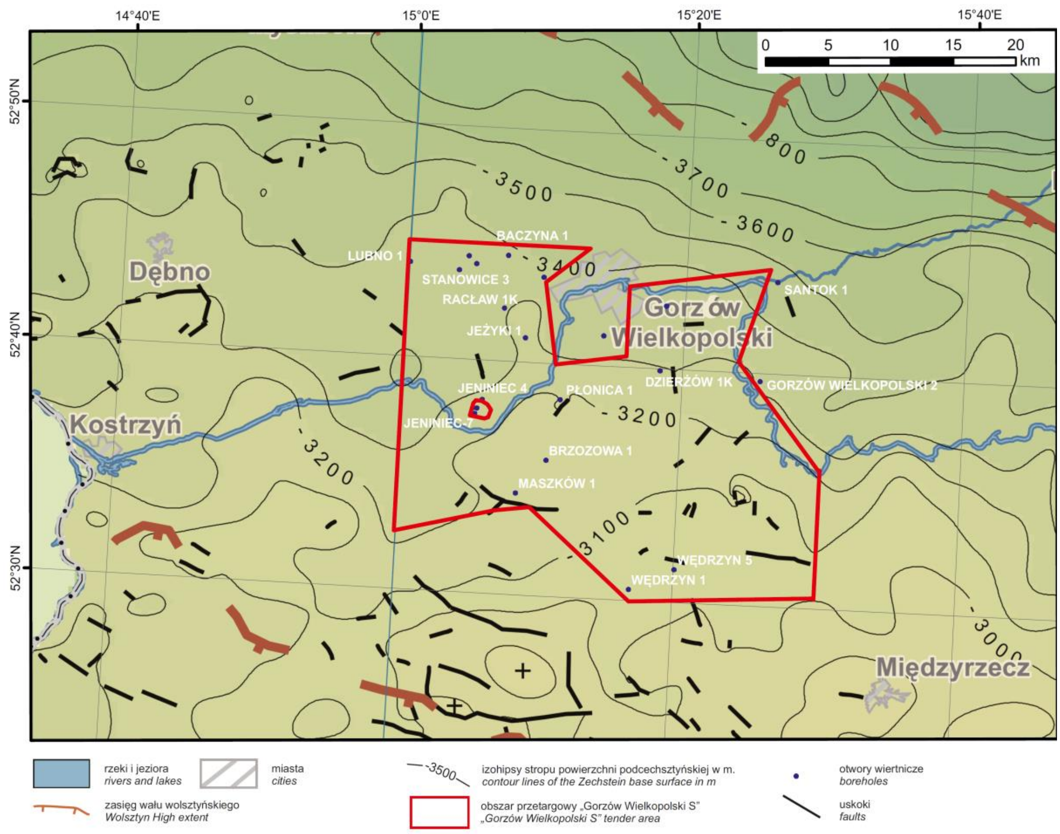


Fig. 2.7. Location of the **"**Gorzów Wielkopolski S" tender area on the structural map of the Zechstein base surface (Kudrewicz, 2008; modified).

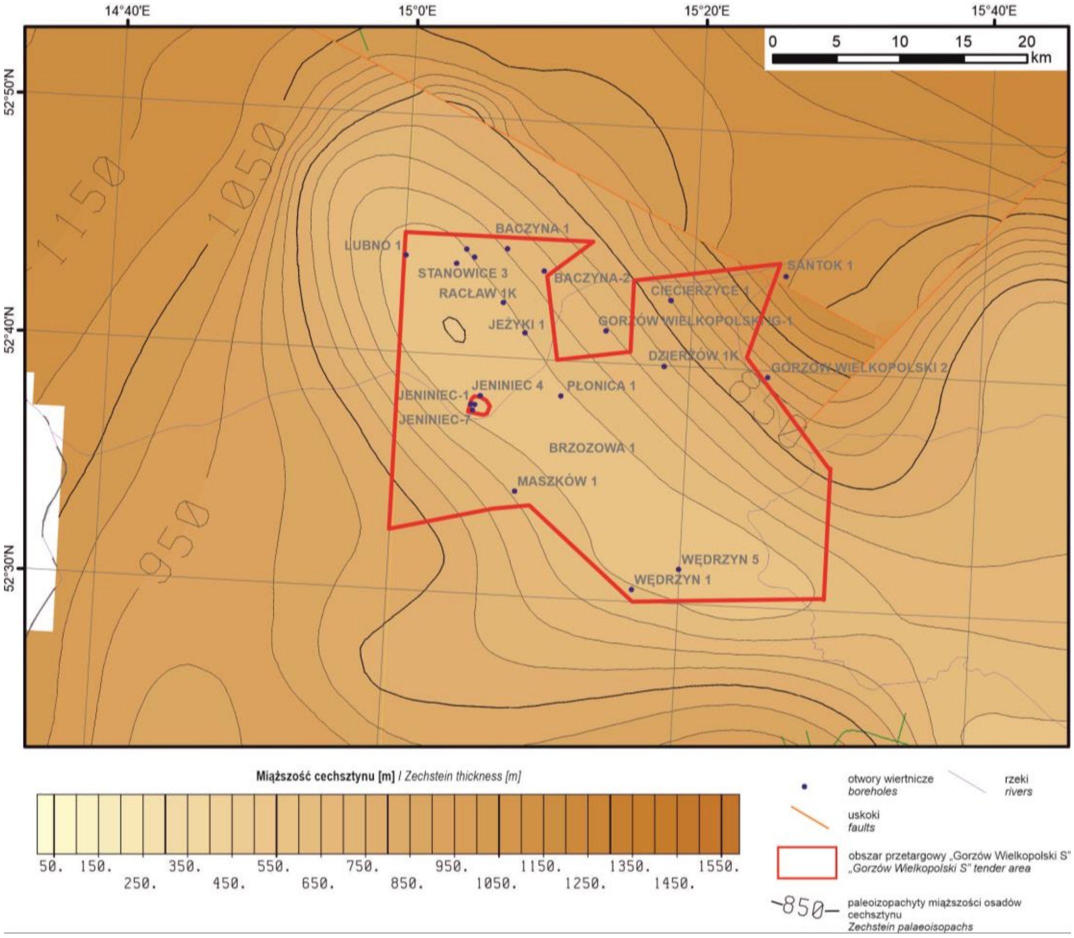


Fig. 2.8. Location of the "Gorzów Wielkopolski S" tender area on the map of the Zechstein thickness (Wagner et al., 2008; modified).

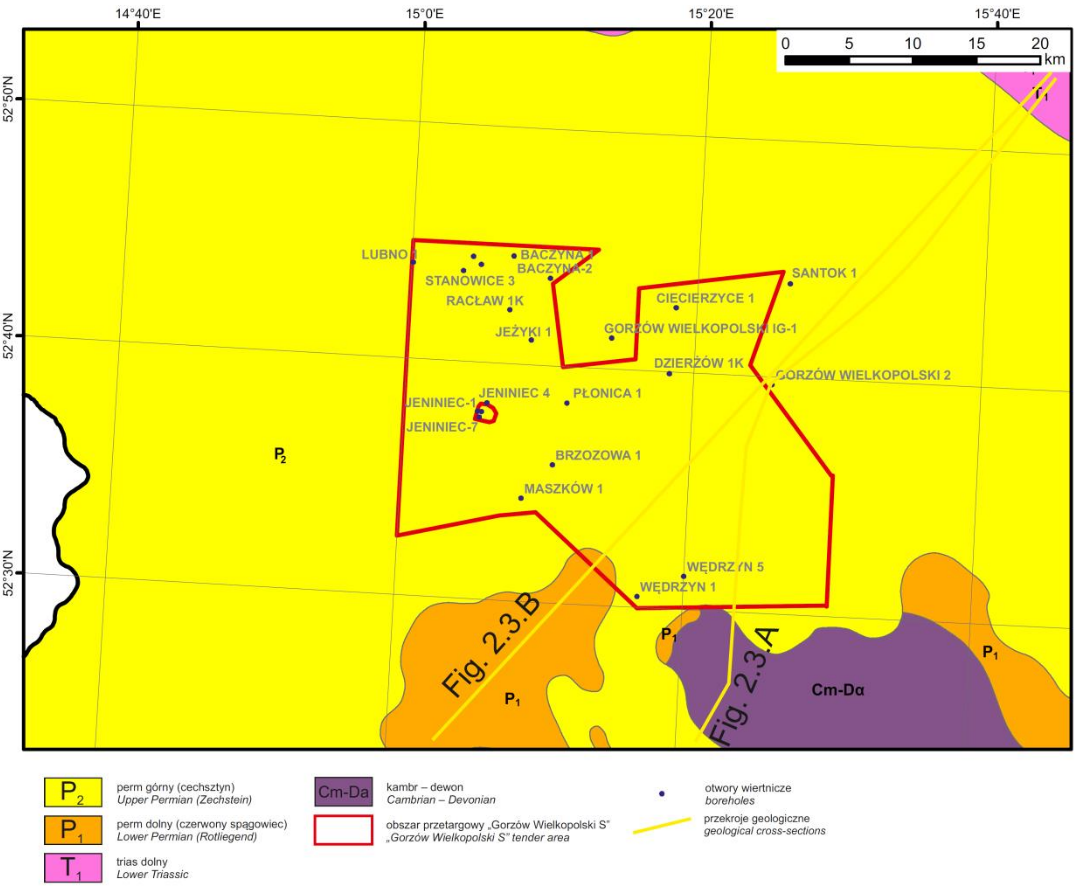


Fig. 2.9. Location of the "Gorzów Wielkopolski S" tender area on the map of horizontal cutting at 3000 m b.s.l. (Kotański, 1997; modified).

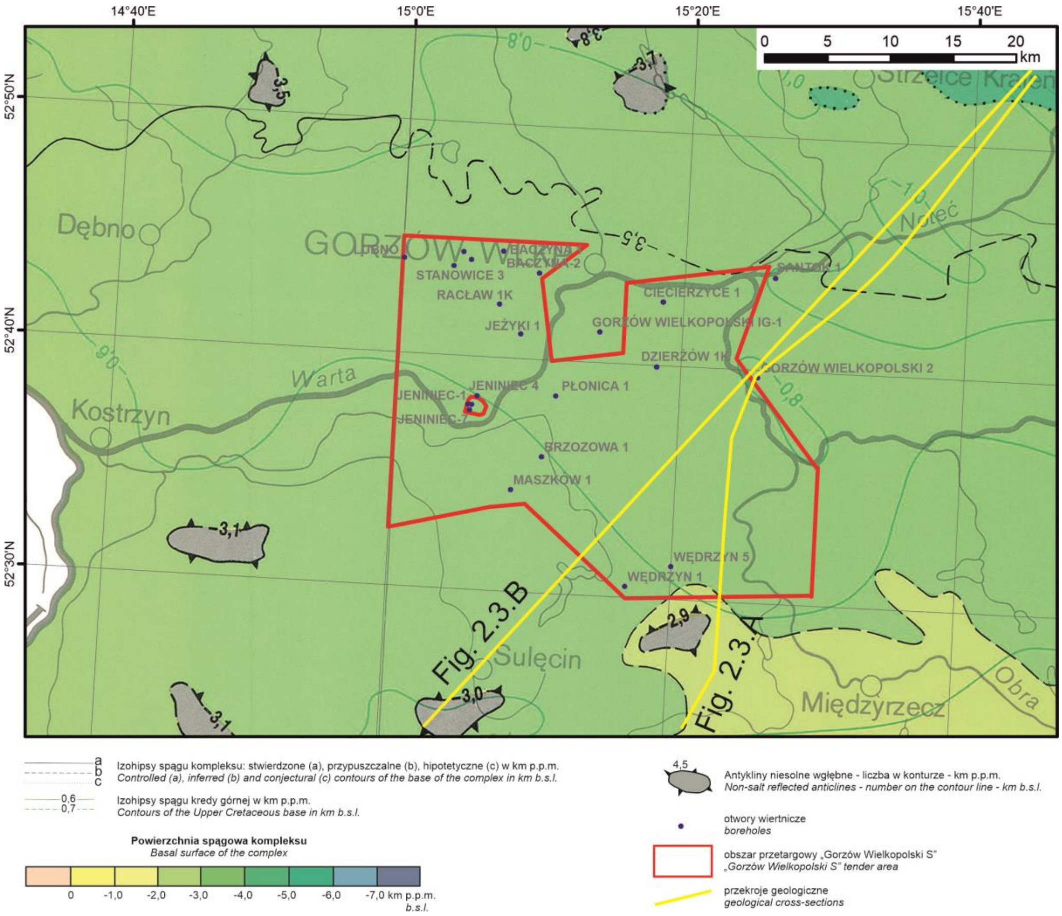


Fig. 2.10. Location of the "Gorzów Wielkopolski S" tender area in relation to the structural elements of the Zechstein-Mesozoic complex in Poland (Dadlez et al., 1998a; modified).

Fig. 2.11. Location of the "Gorzów Wielkopolski S" tender area on the Geological Map of Poland without Cenozoic deposits (Dadlez et al., 2000; modified).

2.2. STRATIGRAPHY
2.2.1. CARBONIFEROUS

Extent and thickness

The Carboniferous rocks in the "Gorzów Wielkopolski S" tender area have not been drilled so far. They were recognized only in two wells located outside the area. The first well is the Jeniniec 2, located near the Jeniniec oil field, and the second well – Santok 1 – is located outside the northeastern border of the tender area (Fig. 5.1). The Carboniferous rocks in the Jeniniec 2 well were drilled at depths 3638.0–3796.0 m (≥158.0 m thick).

Lithology and stratigraphy

Based on the archival core description and geophysical logging (PG and PNG), the Carboniferous succession in the Jeniniec 2 well can be divided into two parts (Fig. 2.13). The lower part (>72 m thick) occurs from the bottom to a depth of about 3724.0 m. It is characterized by an increased amount of sandstone-mudstone-claystone interbeds (Fig. 2.13). The sandstone packages are brownish fine- to medium-grained quartzite. The upper part of the Carboniferous (86 m thick) is dominated by sandstone packages (Fig. 2.13). According to the final well report (Liberska, 1988a), lithologically undefined rocks occur in the uppermost part of the succession; based on the description of cores and geophysical logs, they were interpreted as interbeds of mudstones and sandstones (Figs 2.12–2.13).

The Carboniferous succession shows strong tectonic deformation, as evidenced by steep dipping up to 80° and strong compression, especially in the mudstone and claystone intervals (Mazur et al., 2003).

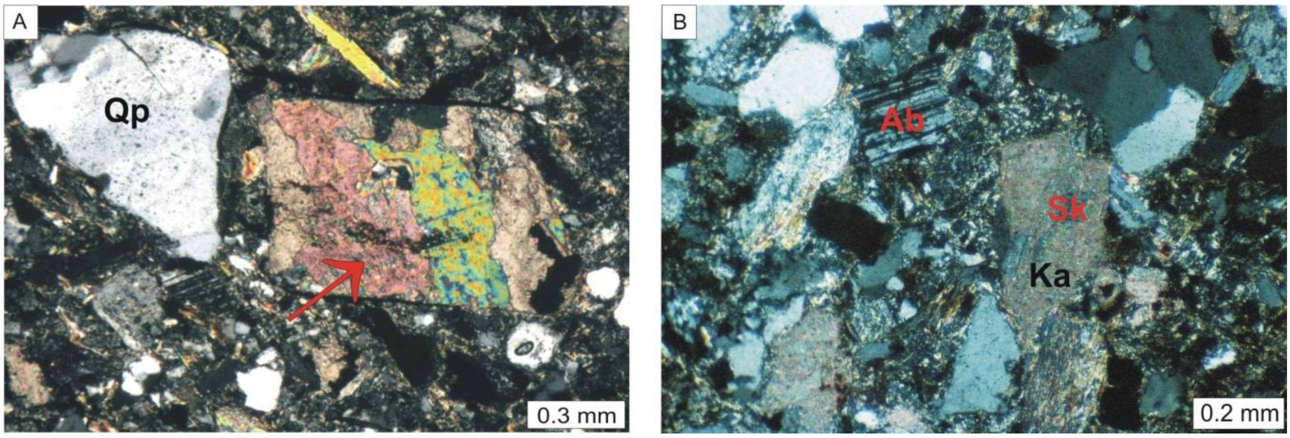


Fig. 2.12.A. Grain of quartz (Qp) and a calcite-anhydrite pseudomorph after feldspar (arrow) in wacke; Santok 1 well, depth 3892.7 m., crossed nicols (Maliszewska et al., 2008). **B.** Grain of K-feldspar (Sk) replaced by calcite (Ka) in wacke, with an albitized plagioclase grain (Ab); Santok 1 well, depth 3896.4 m., crossed nicols (Maliszewska et al., 2008).

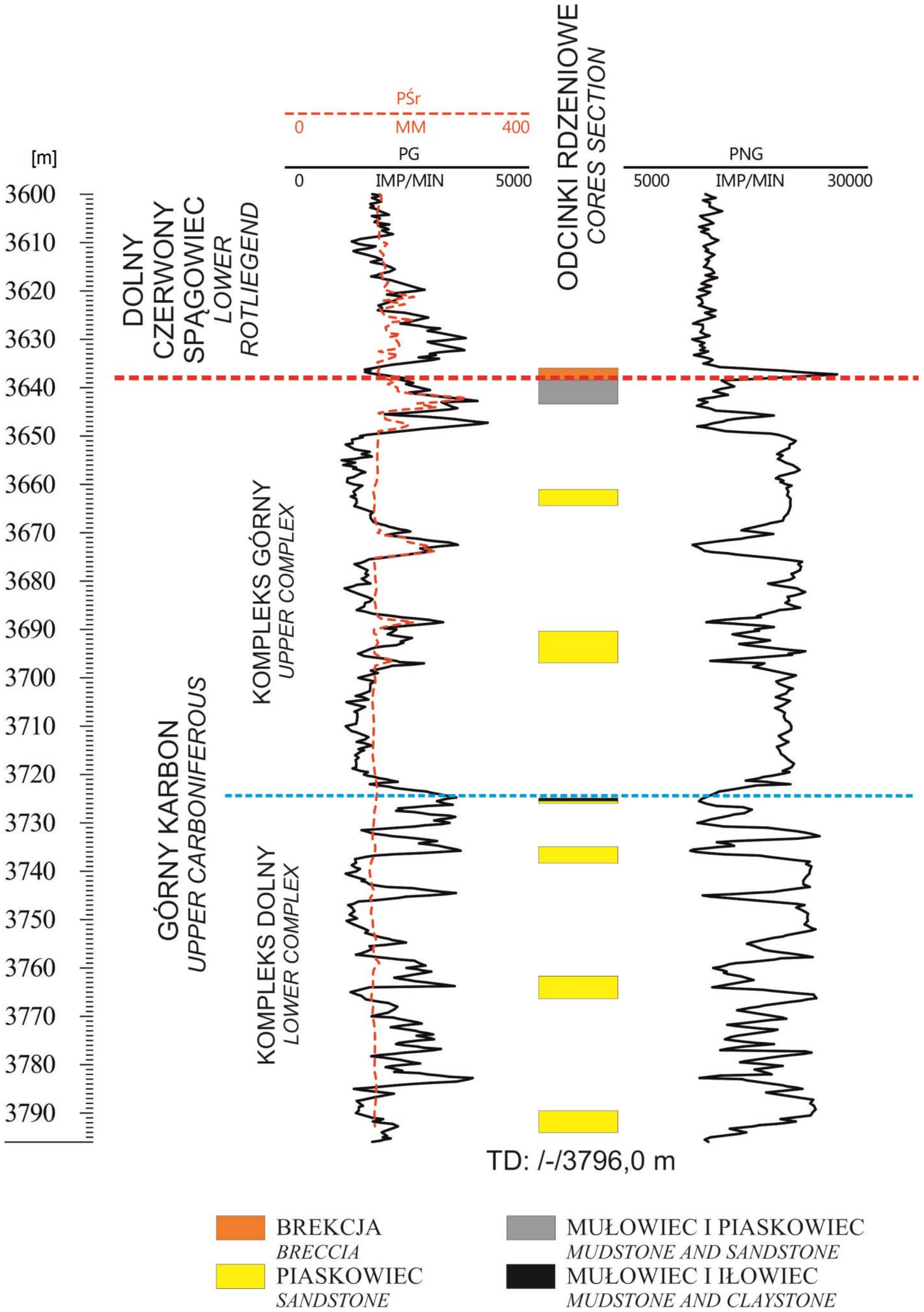


Fig. 2.13. Stratigraphy, well logs, and lithology of the Upper Carboniferous and Lower Permian in the Jeniniec 2 well. Interpretation and graphic design: K. Waśkiewicz (unpublished materials).

2.2.2. PERMIAN – ROTLIEGEND

Extent and thickness

The Rotliegend strata were drilled in 6 deep wells within the "Gorzów Wielkopolski S" tender area, at depths:

- Jeniniec 4: 3261.5–3290.0 m,
- Jeżyki 1: information restricted,
- Maszków 1: information restricted,
- Płonica 1: information restricted,
- Wędrzyn 1: 3141.0–3170.0 m,
- Wędrzyn 5: 3157.5–3210.0 m.

Additionally, in the Jeniniec oil field, one well drilled through the Rotliegend succession (Jeniniec 7) and one well pierced it (Jeniniec 2). The Rotliegend thickness in the wells varies from 28.5 m to 120 m. Only in the Jeniniec 2 well the Rotliegend formations of 386 m in thickness were pierced.

Lithology and stratigraphy

According to an informal stratigraphic subdivision of the Rotliegend deposits proposed by Pokorski (1981, 1988, 1997), the Lower Rotliegend formation corresponds to the traditional Autun stage. It is represented mainly by volcanic and subordinate volcanoclastic rocks (epiclastic-pyroclastic series).
The Upper Rotliegend is composed of sedimentary rocks.

Lower Rotliegend

The Lower Rotliegend in the tender area is represented by the Wielkopolska Volcanic Formation (Pokorski, 1981, 1988, 1997). It consists of two types of effusive volcanic rocks: 1) basalts, andesites and trachyandesites, and 2) rhyolites, dacites and trachytes.
A regional thickness increase of the volcanic series to the NW is observed (Fig. 2.6).

In the Gorzów Block area and vicinity, a geologic correlation was made in boreholes that drilled Lower Rotliegend rocks reaching the Carboniferous (Fig. 2.14).
Between Jeniniec 2 and Santok 1 wells, faults occurring in the Carboniferous basement did not affect the Lower Rotliegend volcanic cover (Figs 2.14–2.15). At the early stage of the Permian Basin development, before the volcanic cap was formed, there had been a fault located northeast of the Santok 1 well and an associated tectonic threshold (Fig. 2.15). Subsequent tectonic evolution produced a tectonic zone located SW of the Santok 1 well, which downthrust the Santok block by about 150 m (Fig. 2.16). The area located NE of the Santok well was thrust down by some further 500 m (Fig. 2.16).

Upper Rotliegend

The Upper Rotliegend was recognized in 6 wells located within the "Gorzów Wielkopolski S" tender area and its vicinity. This succession is composed of gray fine- to medium-grained quartz sandstones. The Upper Rotliegend succession in the "Gorzów Wielkopolski S" tender area is only residually preserved. It forms a limited, very thin sedimentary cover. The thicknesses of the Upper Rotliegend vary from 1.5 to 5 m. The distribution of different tectonic fault zones associated with the Upper Rotliegend sedimentary cover (indicating a possible existence of numerous tectonic traps at the Zechstein basement surface) can be found in Fig. 2.17.

Lower Rotliegend reservoir potential

A recent discovery of high-methane gas (91% CH_4) in porous volcanic rocks of the Lower Rotliegend in the Goszczanowo 1K well, located to the east of the Ciecierzyce 1/1K and Santok 1 wells, may suggest that such traps may also exist in the "Gorzów Wielkopolski S" tender area. To date, the Lower Rotliegend volcanics have not been studied in detail for petroleum exploration. The performed researches were in many cases limited only to the petrological description of these rocks (e.g. Maliszewska et al., 2016), explanation of their genesis (e.g. Bylina, 2006), and studies of petrophysical properties (final well reports). However, varying porosity around 5% average, and low permeability <1 mD, are typical for those sediments. Despite the poor/medium petrophysical properties, high hydrocarbon gas inflows have been recorded in many wells. Assuming vertical migration and taking into consideration results of, e.g., Goszczanowo 1K, the presence of the Upper Carboniferous (source rocks) enclaves below the Lower Rotliegend volcanic rocks is possible (Fig. 2.17). A key factor to understand the role of the Lower Rotliegend (volcanic rocks) as potential reservoir rocks is to perform detailed petrological and diagenetic studies, combined with petroleum modeling. Additionally, it is suggested that the Zechstein basement should be remapped and the location of fault zones, in which the Lower Rotliegend volcanic rocks may form structural traps and potential fracture-type reservoir rocks, should be reinterpreted.

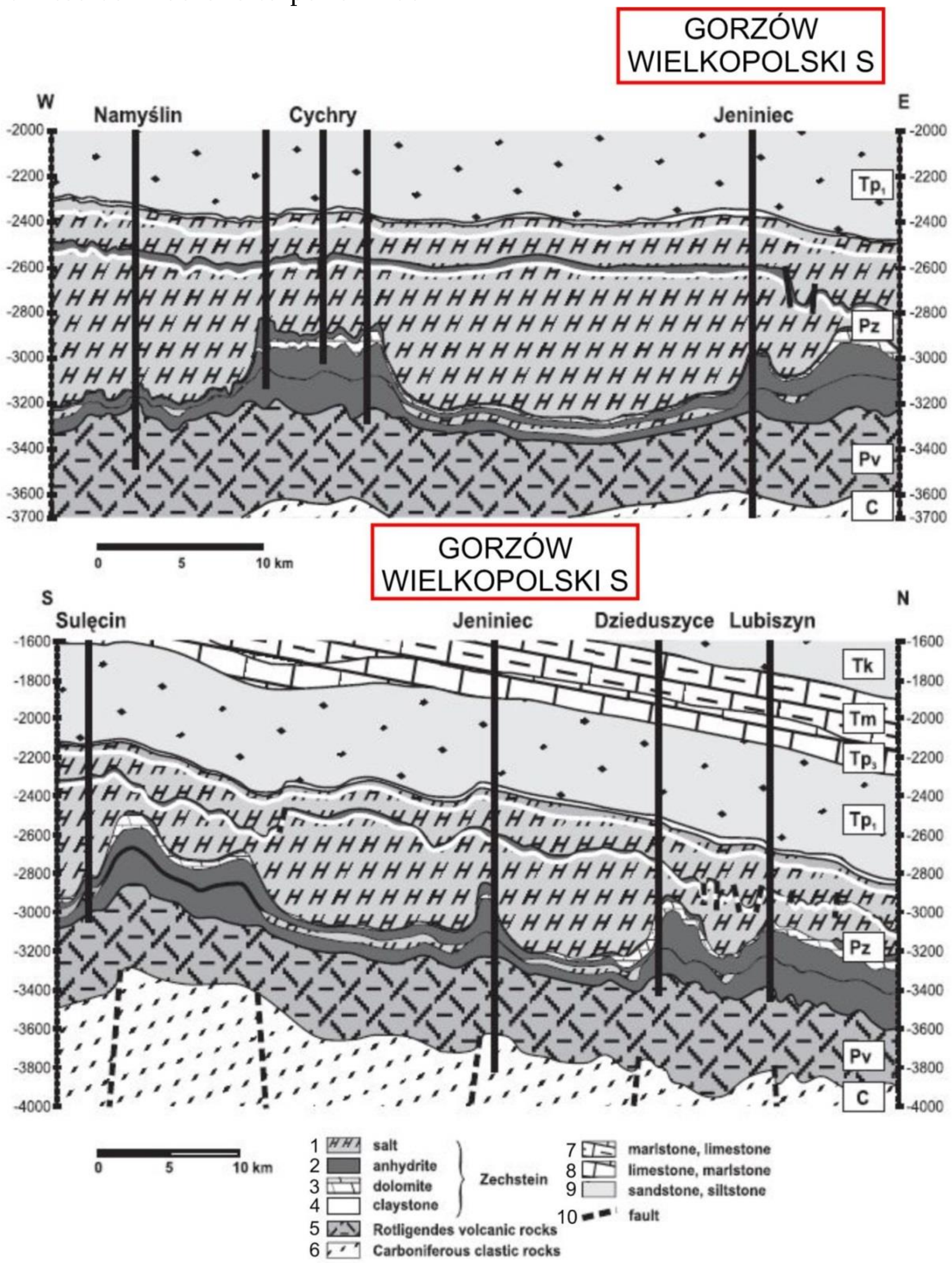


Fig. 2.14. Geological interpretation of deep seismic cross-sections Namyślin – Jeniniec and Sulęcin – Lubiszyn (Dyjaczyński and Dąbrowska-Żurawik, unpublished materials; in Bylina, 2006). C – Carboniferous, Pv – Lower Rotliegend, Pz – Zechstein, Tp1 – Buntsandstein, Tp3 – Rhoetian, Tm – Muschelkalk, Tk – Keuper.

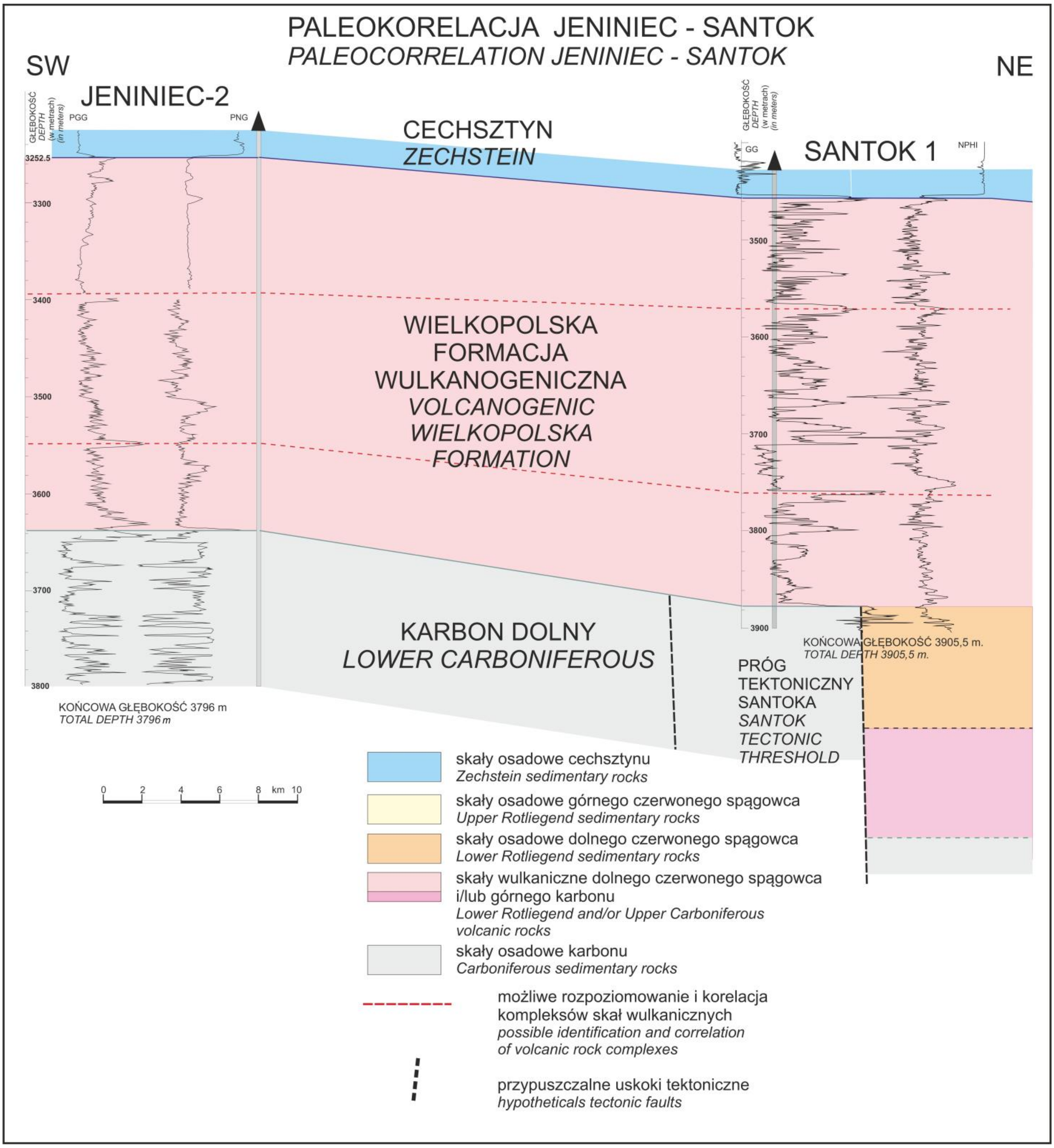


Fig. 2.15. Geological correlation between Jeniniec 2 and Santok 1 wells. Interpretation by H. Kiersnowski (unpublished materials). The location of the geological cross-section can be found in Fig. 2.16.

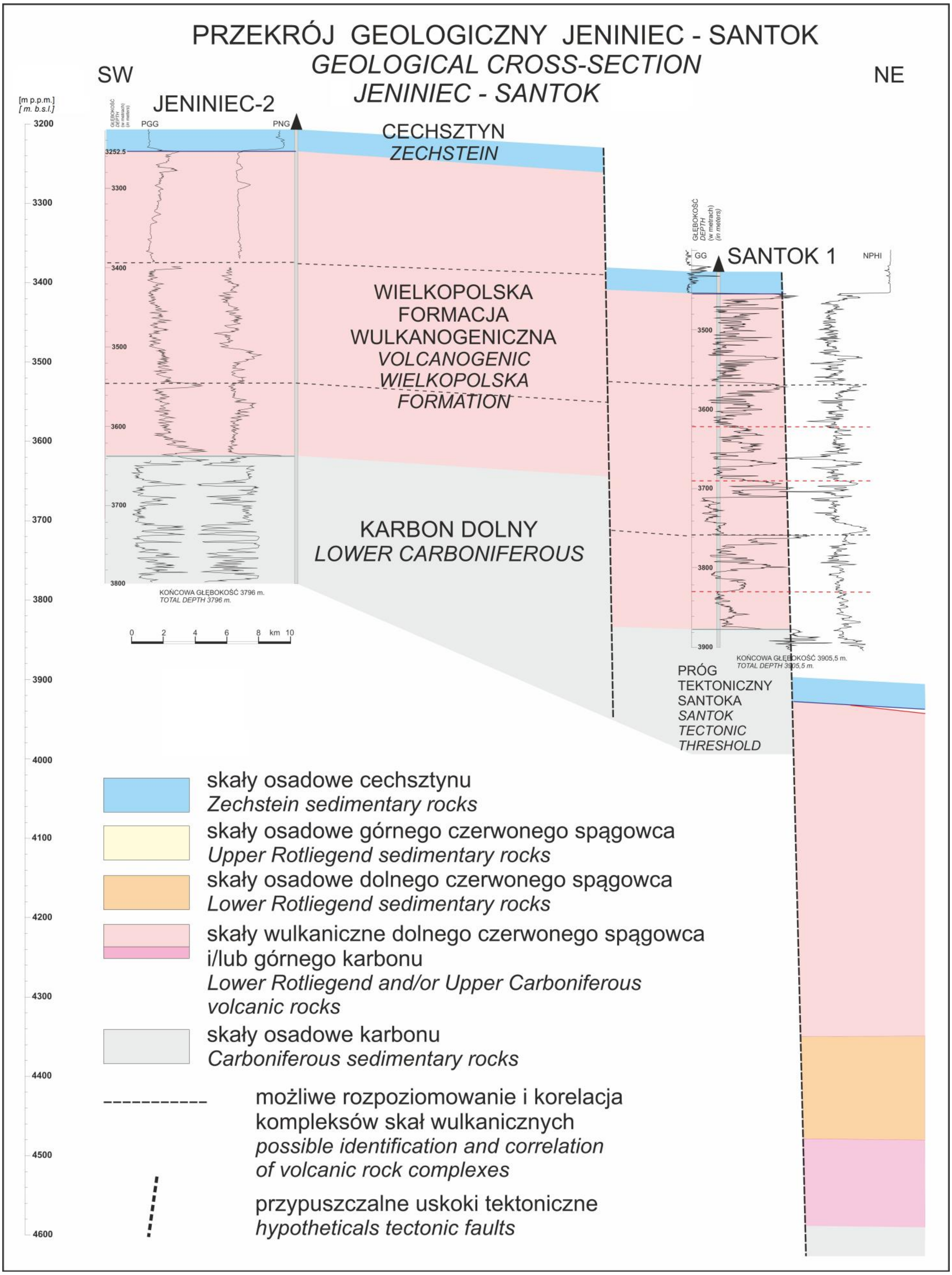


Fig. 2.16. Geological correlation between Jeniniec 2 and Santok 1 wells. Current view. Interpretation by H. Kiersnowski (unpublished materials). The location of the geological cross-section can be found in Fig. 2.16.

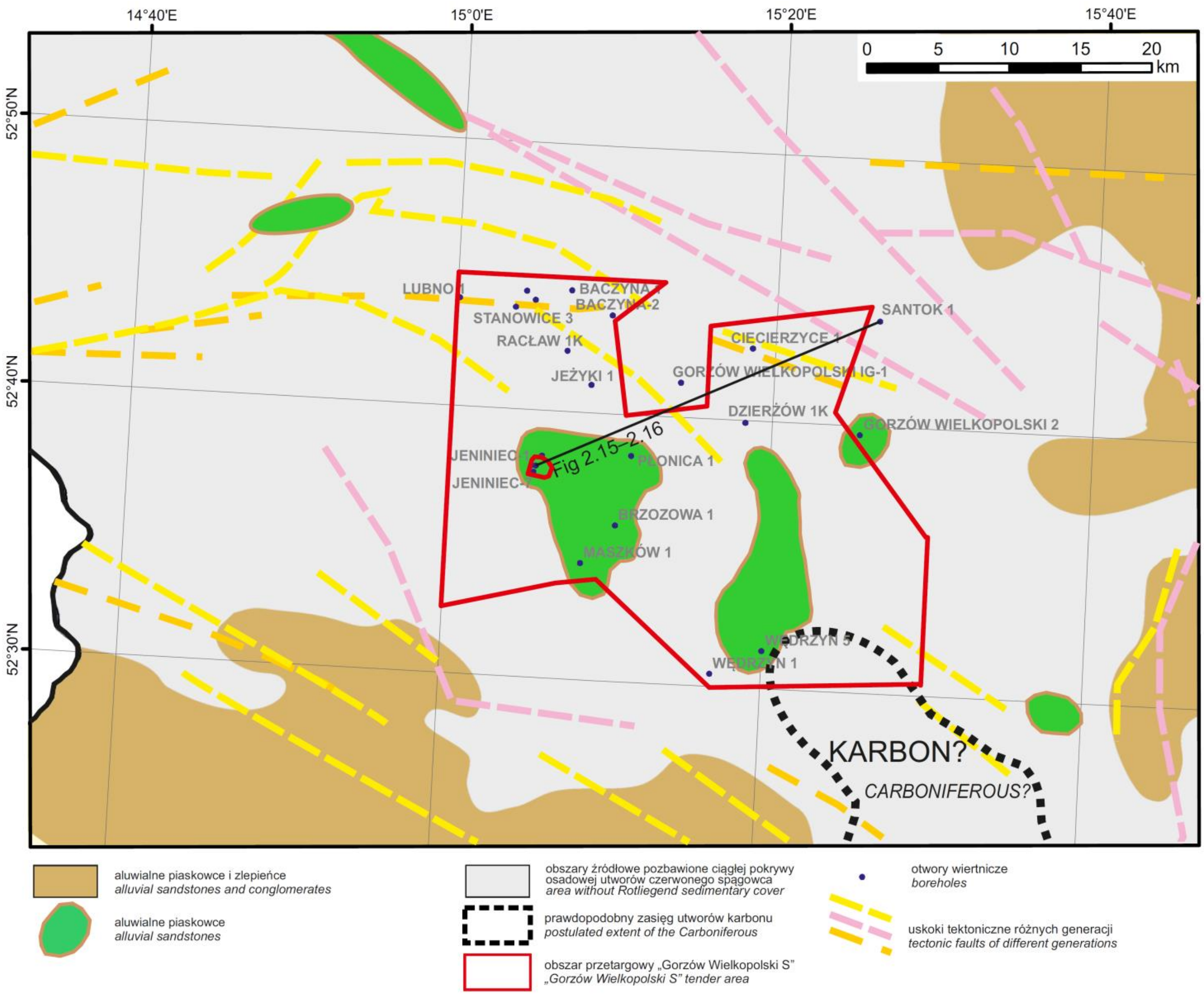


Fig. 2.17. Upper Rotliegend lithofacies and paleogeography just before the Zechstein transgression (after Waśkiewicz and Kiersnowski, 2020) with location of the "Gorzów Wielkopolski S" tender area.

2.2.3. PERMIAN – ZECHSTEIN

Extent and thichness

The Zechstein deposits in the "Gorzów Wielkopolski S" tender area were drilled in 18 wells at depths:

- Baczyna 1: information restricted,
- Baczyna-2: 2689.0–3167.0 m,
- Brzozowa 1: information restricted,
- Ciecierzyce 1: 2620.5–3204.0 m,
- Ciecierzyce 1K: 2679.0–3007.0 m TVD,
- Dzierżów 1K: 2531.43–3031.87 m TVD,
- Dzierżów 1K-BIS: 2533.1–3034.1 m TVD,
- Jeniniec 4: 2372.5–3261.5 m,
- Jeżyki 1: information restricted,
- Lubno 1: information restricted,
- Maszków 1: information restricted,
- Płonica 1: information restricted,
- Racław 1K: 2732.0–3256.0 m,
- Stanowice 1: information restricted,
- Stanowice 2: information restricted,
- Stanowice 3: 2726.0–3261.0 m,
- Wędrzyn 1: 2361.0–3141.0 m,
- Wędrzyn 5: 2391.0–3157.5 m.

The Zechstein succession in the "Gorzów Wielkopolski S" tender area attains several hundred meters in thickness (Fig. 2.18). The maximum total thickness of 889 m was reported in the Jeniniec 4 well.

In many cases, the Zechstein was not pierced, and the only 6 wells pierced the whole Zechstein succession: Jeniniec 4, Jeżyki 1, Maszków 1, Płonica 1, and Wędrzyn 1 and 5,.

Lithology and stratigraphy

Four cyclothems – PZ1 to PZ4 – were identified in the Zechstein succession in the "Gorzów Wielkopolski S" tender area (Wagner, 1994, Wagner and Peryt, 1997; Fig. 2.19). They correspond to the Werra, Strassfurt, Leine and Aller cyclothems from the German Basin (Richter- Bernburg, 1955). Most of the Zechstein deposits were formed during transgressive-regressive carbonate-evaporite cycles (PZ1–PZ3; Fig. 2.20), while the uppermost part of the succession (cyclothems PZ4a to PZ4e; Fig. 2.21) – during the terrigenous-carbonate climate cycles, associated with fluctuations from humid to dry climate (Wagner and Peryt, 1997).

Deposition of the PZ1–PZ3 cyclothems generally started with carbonates, but in the case of the PZ1 and PZ3, carbonate deposition was preceded by sedimentation of clays of the T1 Kupferschiefer (usually several cm thick) and T3 Grey Pelite, respectively. The carbonate formations are as follows: Zechstein Limestone Ca1, Main Dolomite Ca2, and Platy Dolomite Ca3 (Figs 2.19–2.21). They are usually relatively thin (from several meters to several tens of meters) and are separated by very thick evaporite layers (up to several hundred meters) – mainly sulfate (anhydrite) and chloride (halite) rocks.

PZ1 cyclothem

The PZ1 cyclothem in the "Gorzów Wielkopolski S" area varies from over 190 m (Wędrzyn 5 well) to almost 260 m (Jeniniec 4 well) in thickness (Tab. 2.1). According to the final well reports, no Kupferschiefer was found in the Jeniniec 4, Wędrzyn 1 and 5 wells (Tab. 2.1; see Liberska, 1988b; Sowa et al., 2017).

Deposition of the Zechstein Limestone (Ca1) in the "Gorzów Wielkopolski S" area took place in the deep-water zone of the basin plain (Fig. 2.22). As a consequence, the sediments are not very thick (Jeniniec 4 – 1 m, Wędrzyn 5 – 3 m), and are represented by mainly by limestones (Fig. 2.23) with very poor reservoir properties.

The Ca1 cover – an evaporitic succession belonging to the Lower Anhydrite and the Upper Anhydrite, is up to 250 m thick (Fig. 2.23). In theWędrzyn 1 and 5 wells, the Oldest Halite, about 50 m thick, was found as well. It separates the above-mentioned anhydrite units.

PZ2 cyclothem

The thickness of the PZ2 cyclothem in the "Gorzów Wielkopolski S" tender area varies from over 100 m (118 m in the Dzierżów 1K well – possible tectonic reduction) to almost 360 m (359 m in the Jeniniec 4 well; Fig. 2.24, Tab. 2.1). The Main Dolomite (Ca2) as the lowermost unit has a very diverse thickness related to the palaeogeography of the basin. Platforms and sulfate microplatforms of the PZ1 cyclothem formed hills, on which, as a result of another transgressive cycle, carbonate platform deposition of the Main Dolomite developed (Czekański et al., 2010; Fig. 2.25). The Main Dolomite in the "Gorzów Wielkopolski S" area is dominated by carbonate platform facies (Fig. 2.25–2.26). Therefore, the unit is significantly thick there, locally reaching almost 100 m (94.5 m in Racław 1K well and 94 m in the Stanowice 3 well), but usually the thickness oscillates around 50 m (Fig. 2.26). The western and eastern parts of the area were dominated by basin plain environments (Fig. 2.25-2.26), in which thinner Main Dolomite sediments developed. In the Jeniniec 4 well, it is only 0.5 m thick, while in the Wędrzyn 1 well, located near the slope of the carbonate platform, the Main Dolomite is 6 m thick.

The Main Dolomite originally developed as limestones, now is almost completely dolomitized. Within the carbonate platform environments, three palaeofacies zones, characterized by different microfacies development (Jaworowski and Mikołajewski, 2007; Czekański et al., 2010; Fig. 2.25-2.27), can be distinguished (Wagner, 2012). These are:

- Slope of a carbonate platform. Depending on its morphology, it is built of sandy mudstones, carbonate sandstones, conglomerates and carbonate breccias. Conglomerates and anhydrite breccias are also present in some sections. They are represented by mudstones, packstone, floatstone, and rudstone microfacies.

- Barrier that separates the platform plain area from the open sea. The barrier was composed of grain sediments deposited in a shallow, high-energy environment. Microfacies such as ooid or oncoid grainstones prevail; packstones, wackestones, rudstones and floatstones are less frequent.
- Platform flat, where shallow-water conditions prevailed. Small differences in bathymetry resulted in the development of high- and low-energy zones The high-energy zone sediments are composed of ooid grainstones with microbialite interbeds. Biostabilization of sediments is commonly visible. Low-energy zone sediments, associated with intra-platform depressions, are dominated by mudstones, wackestones, and peloid packstones with oncoids and numerous bioclasts.

For example, in the Dzierżów 1K and 1K-BIS wells, the Main Dolomite is represented by diverse microfacies, dominated by coarse-grained deposits – packstones and grainstones, formed in various environments within the barrier and the outer slope of the carbonate platform. In the Stanowice 3 well, the Main Dolomite is dominated by packstones, grainstones, and floatstones, originated in the carbonate platform slope and various environments associated with the carbonate platform. In the Raclaw 1K well, representing the marginal part of the carbonate platform, grainstones and oncoid-intraclastic-peloid packstones with intercalations of microbialites/stromatolites predominate. In the lowest part of the profile, floatstones with interbeds of grainstones and packstones are present as well.

The reservoir properties of the upper and middle parts of the Main Dolomite succession in the mentioned wells can be considered as good. In contrast, the lower part of the succession is characterized by poor porosity.

The Basal Anhydrite, which ooverlies the Main Dolomite (Tab. 2.1), is mainly developed as crystalline anhydrite (Sowa et al., 2017). It reaches the thickness from several to about 20 m (20.2 m in the Stanowice 3 well). Increased thickness of anhydrite may occur on small elevations of the basement. The bottom paleotopography of the Basal Anhydrite basin was leveled by the Older Halite (Na2), which, in some wells, reaches a thickness exceeding 300 m (maximum 339 m in the Jeniniec 4 well).

In the Racław 1K and Stanowice 3 wells, the Older Potash salt (K2) of 9.5 m and 31 m thickness, respectively, was found. Sedimentation of the PZ2 cyclothem was terminated by the Screening Anhydrite (A2r), whose thickness does not exceed several meters (maximum almost 6 m in Dzierżów 1K-BIS well).

PZ3 cyclothem

The PZ3 cyclothem in the “Gorzów Wielkopolski S” area is about 200 m thick (Fig. 2.28, Tab. 2.1). In the boreholes, its thickness ranges from 159.5 m (Wędrzyn 5e) to over 253 m (Dzierżów 1K-BIS).

In all the wells, sedimentation of the PZ3 cyclothem starts with the Grey Pelite T3 that is several meters thick (from 2 m to a maximum over 6 m in Dzierżów 1K well).

In the upper part of the PZ3 sequence, the thickness of the Main Anhydrite ranges from slightly over 20 m (22 m in Stanowice 3 well) to almost 100 m (Dzierżów 1K well).

The last member of the cyclothem is the Younger Halite Na3 that reaches a thickness from 116 m in the Wędrzyn 1 borehole to 188.5 m in the Stanowice 3 borehole.

PZ4 cyclothem

The PZ4 cyclothem thickness ranges from 48 m (Wędrzyn 1 well) to 102.5 m (Jeniniec 4 well; Fig. 2.29; Tab. 2.1). Its lowest part is represented by the Upper Red Pelite T4a, which is several meters thick and was found in all wells. The Lower Pegmatite Anhydrite (1–2 m thick), and the Youngest Halite (20–65.5 m thick) occur above. In the Jeniniec 4, Stanowice 3, Wędrzyn 1, and Wędrzyn 5 wells, the Zechstein terrigenous series (PZt), ranging from several to 25 m in thickness, was also detected.

Main Dolomite petrography

The Main Dolomite succession in the "Gorzów Wielkopolski S" tender area is dominated by dolomites. Originally, they were deposited as limestones, dolomitized during the diagenesis as a result of reflux of evaporite brines, as it took place in the whole Zechstein Basin (e.g. Peryt and Scholle, 1996). The Main Dolomite deposits have different microfacies and petrographic characteristics depending on which part of the basin they come from (e.g. basin plain or carbonate platform). The wells representing the Main Dolomite carbonate platform environments are dominated by grain sediments – oncoid/ooid grainstones or peloidal packstones. They often contain microbial interbeds. Packstones and wackestones are characteristic for the deeper/interior parts of the platforms. On the platform slope, fine-grained sediments redeposited from shallower environments are intercalated with floatstones and rudstones. Wackestone-type sediments occur in more distal parts of the slope. Grains in the grainstone, packstone and floatstone microfacies are represented by ooids, oncoids, peloids and intraclasts (including fragments of microbialites).

Dolomitization processess led to the formation of intergranular porosity within the originally calcitic components. Diagenetic processes, primarily dolomite and anhydrite cementation, resulted in a significant or complete reduction of the original pore space; primary porosity is much less commonly preserved. In addition, dissolution processes, chemical compaction (formation of stylolites), recrystallization, aggradational neomorphism, and anhydritization were observed. As a result, the identification of the original structural and textural features of the Main Dolomite deposits is difficult.

The Main Dolomite basin plain sediments are represented by laminated dolomitized mudstones, usually without original macroporosity, or containing only larger pores filled with sulfates. In the discussed area, such rocks were drilled only in the Jeniniec 4 and Wędrzyn 1 wells.

To summarize, it can be generally stated that, as it was already noted by Mikołajewski and Słowakiewicz (2008), diagenetic alterations and pore space creation took place in several stages and were related to both –the synsedimentary/early diagenetic stage and the late diagenetic stage. Some of these processes were responsible for poor properties of the Main Dolomite reservoir rocks (dolomite and anhydrite cementation, compaction), while others could significantly improve those properties (selective dissolution, fracturing).
Dolomite and anhydrite cementation had the most adverse effect on preserving the original pore space in the Main Dolomite granular sediments.

Main Dolomite exploration concept

The Main Dolomite succession in the "Gorzów Wielkopolski S" tender area was extensively explored in the past. The northern part of the area and its southern boundaries have good seismic survey and well coverage.

The southern part (except for its southernmost outskirts), covering the basin plain of the Witnica Bay in the west and the Wielkopolska carbonate platform in the east, is relatively poorly recognized – only by 2D seismic survey; there are neither 3D seismic investigations nor wells drilled. Within the carbonate platform area, there are several undrilled structures (Fig. 2.25), located both within the platform itself and at the foot of the platform/slope.

Recommendations:

- Exploration of the Witnica Bay area to find structures similar to the Jeniniec oil field. A 3D seismic survey is recommended. Exploration of the PZ1 anhydrite platform ridges and related carbonate microplatforms is suggested.
- Reinterpretation of 2D seismic survey and 3D imaging in the NE part of the tender area. Work should focus on the searching of structures located within the platform slope and within the adjacent Noteć Bay.

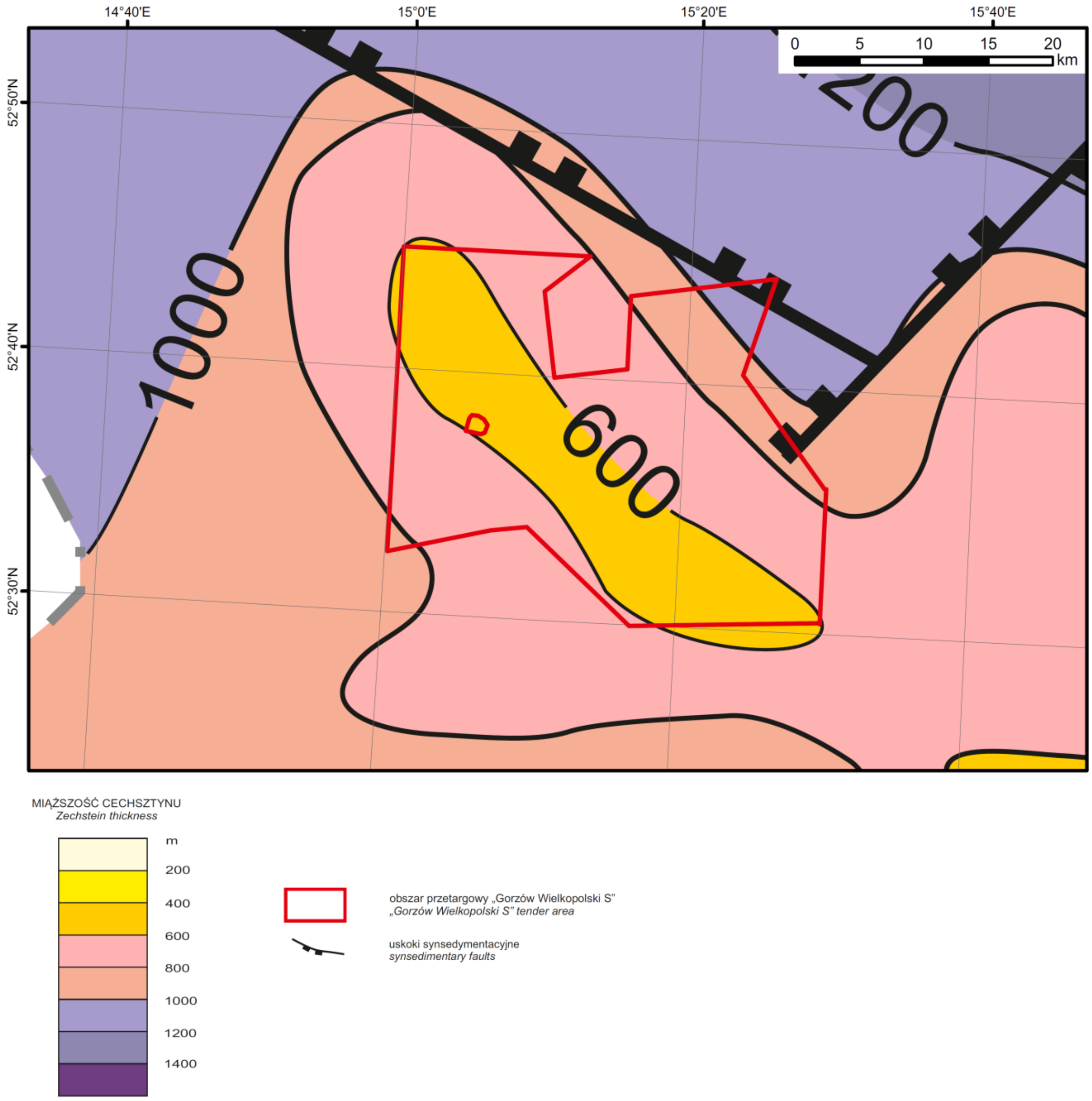


Fig. 2.18. Zechstein thickness in the "Gorzów Wielkopolski S" tender area and adjacent areas (Wagner, 1998; modified).

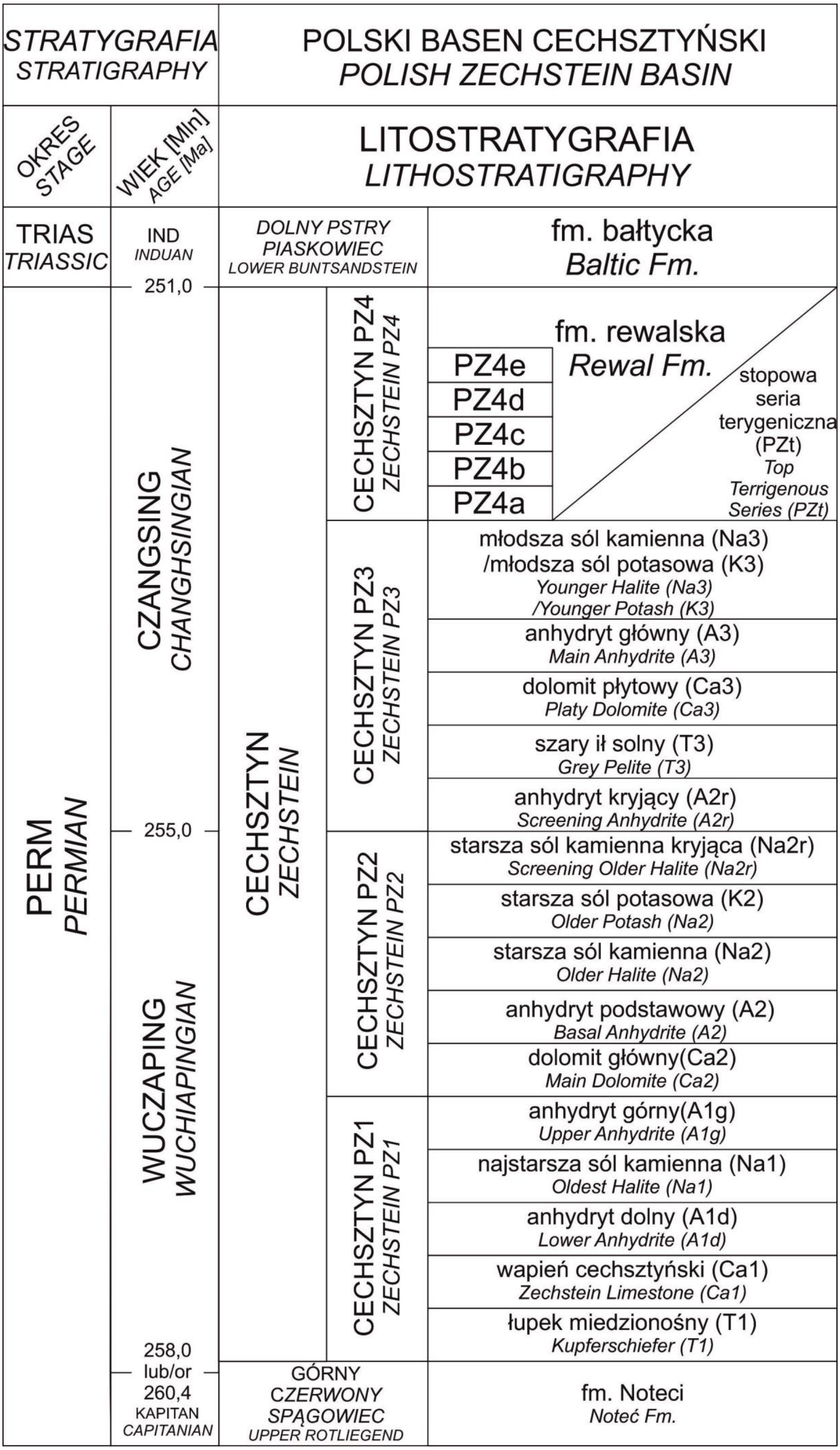


Fig. 2.19. Zechstein stratigraphy in the Polish Permian/Zechstein Basin. Lithostratigraphic subdivision after Wagner (1987, 1988, 1994; after Słowakiewicz and Mikołajewski, 2009; modified).

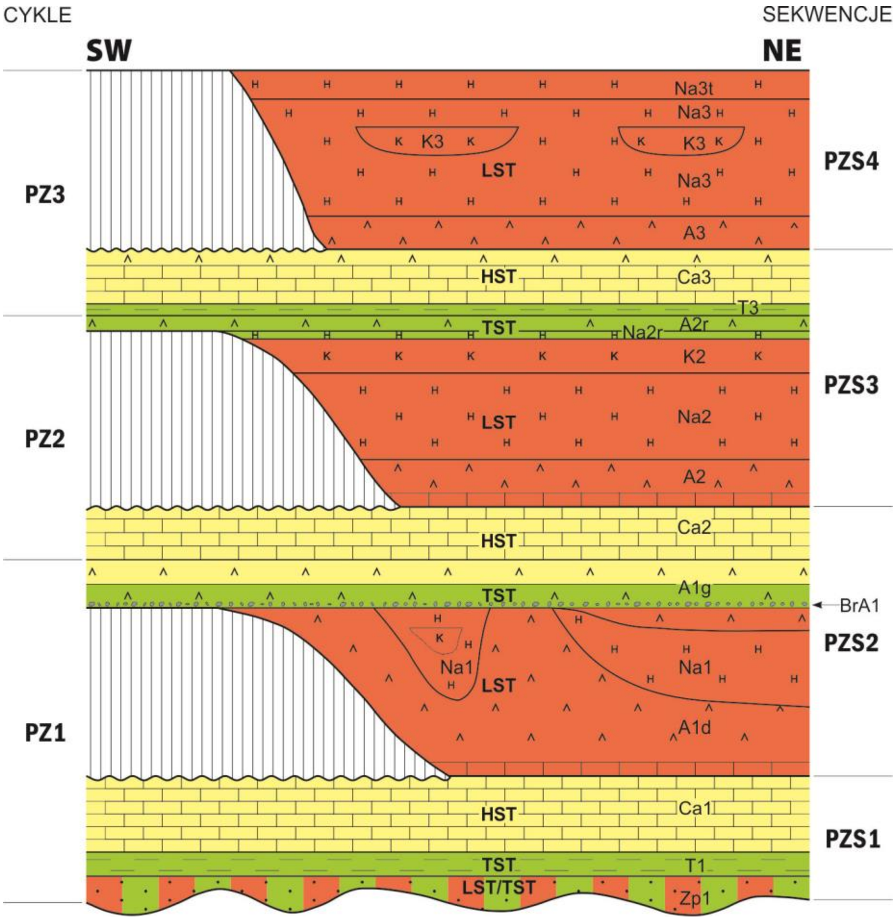


Fig. 2.20. Zechstein stratigraphy –PZ1, PZ2 and PZ3 cyclothems and depositional sequences (Wagner and Peryt, 1997; modified). Explanations in Fig. 2.21.

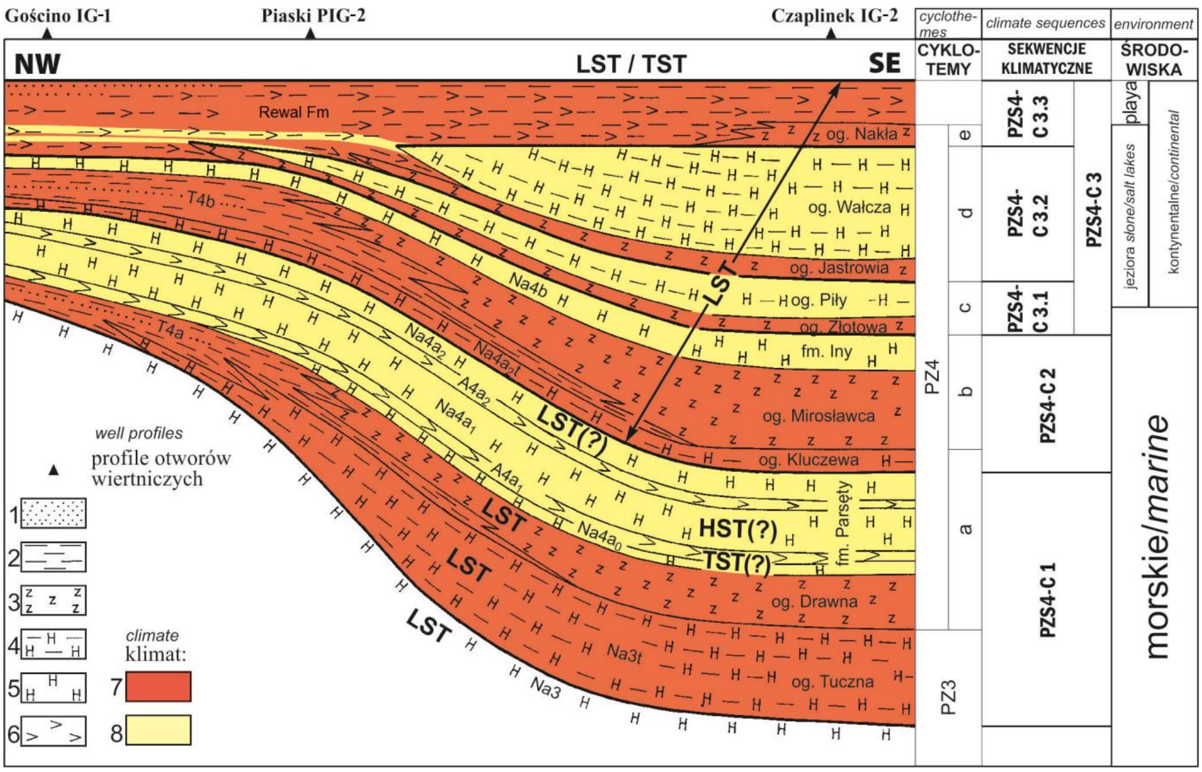


Fig. 2.21. Climatic depositional sequences of the Zechstein PZ4 cyclothem (Wagner and Peryt, 1997; modified). LST – lowstand system tract, TST - transgressive system tract, HST – highstand system tract, 1 – sandstones, 2 – mudstones, claystones, 3 – zuber, 4 – rock salt, claystones, 5 – rock salt, 6 – anhydrites, 7 – humid, 8 – dry.

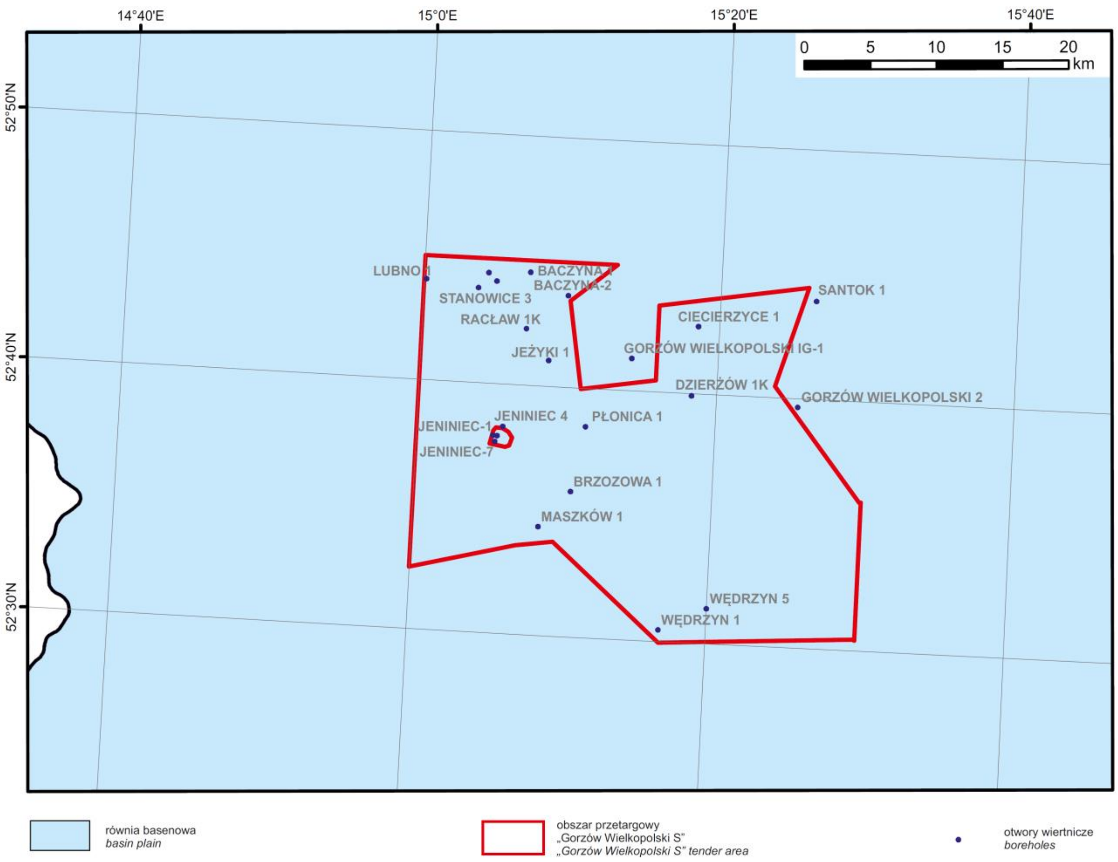
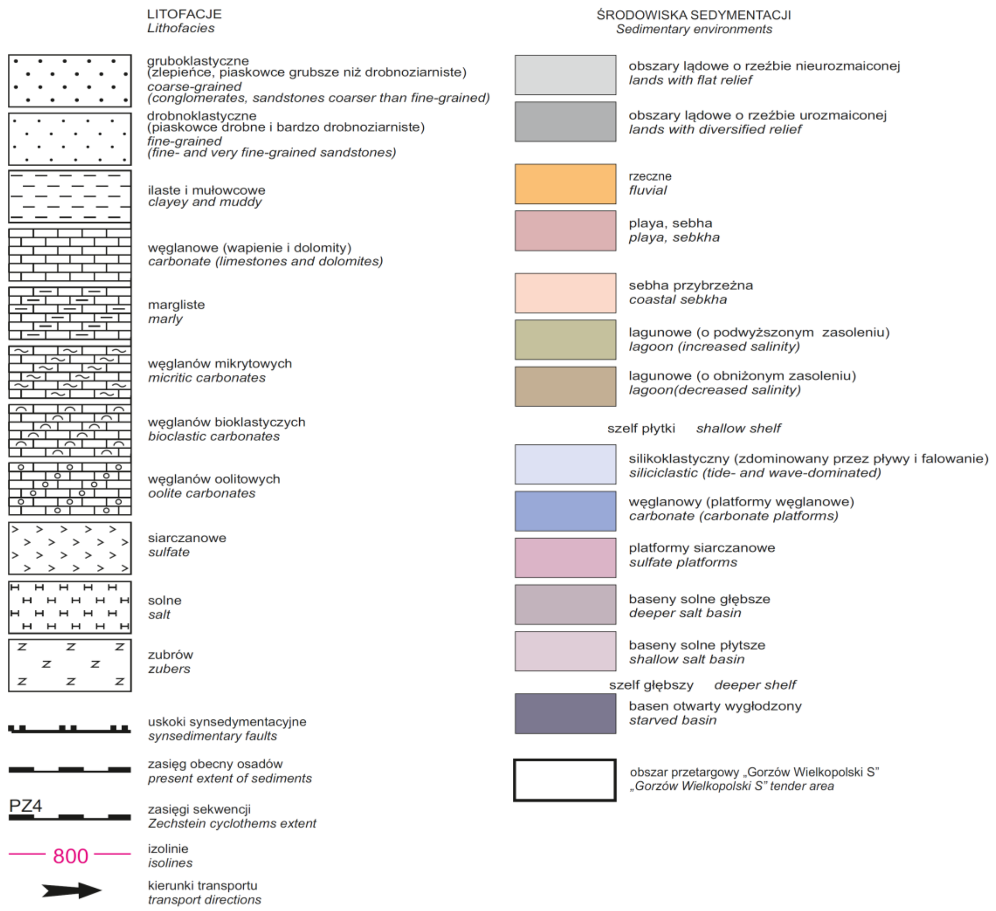


Fig. 2.22. Location of the "Gorzów Wielkopolski S" tender area on the Zechstein Limestone Ca1 palaeogeographic map (Buniak et al., 2013a; modified).



→ Explanation to Figs 2.23–2.24 and Figs 2.28–2.29 (Wagner, 1998; modified).

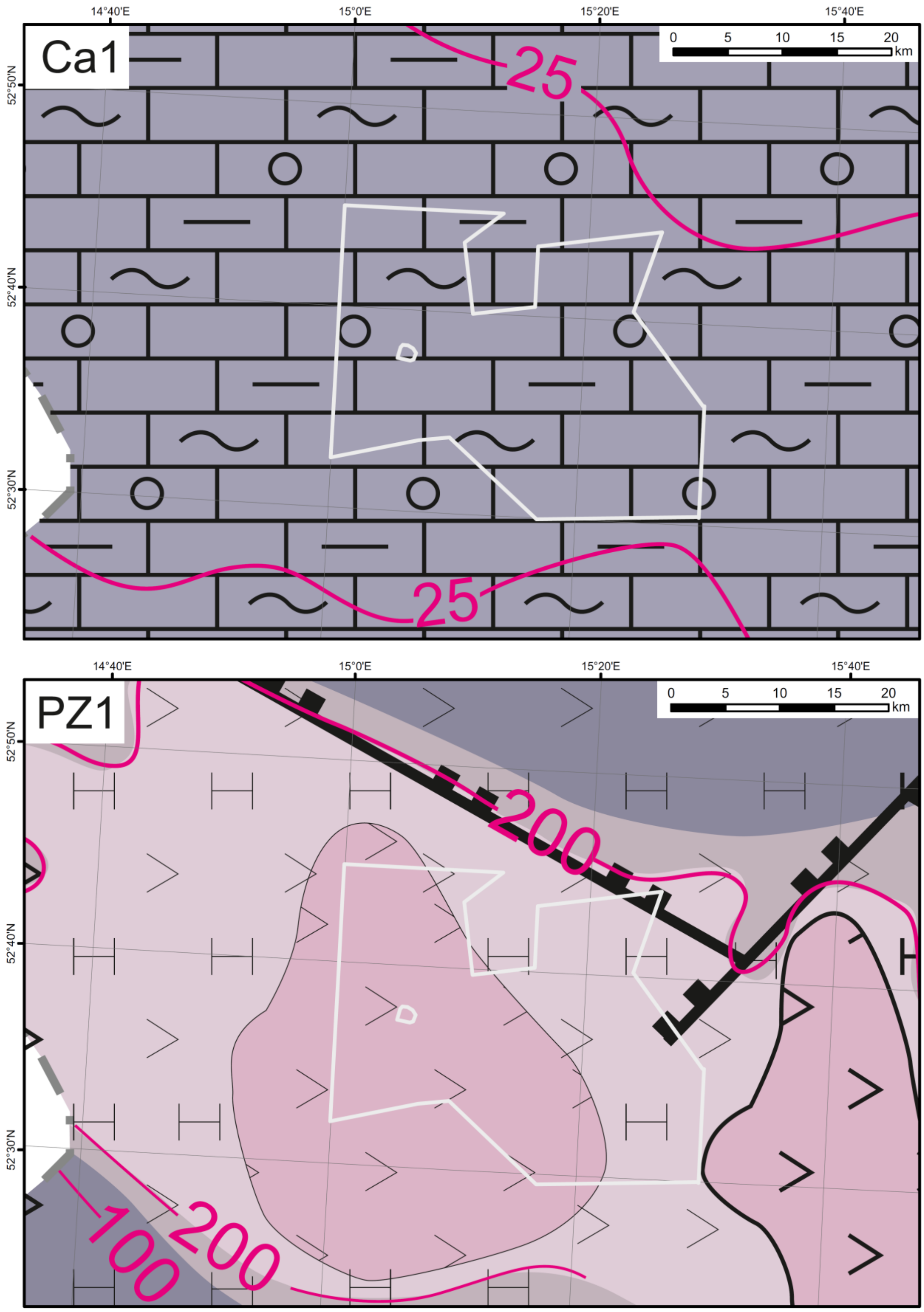


Fig. 2.23. Location of the "Gorzów Wielkopolski S" tender area on the Zechstein Limestone Ca1 and PZ1 cyclothem palaeogeographic-thickness map (Wagner, 1998; modified).

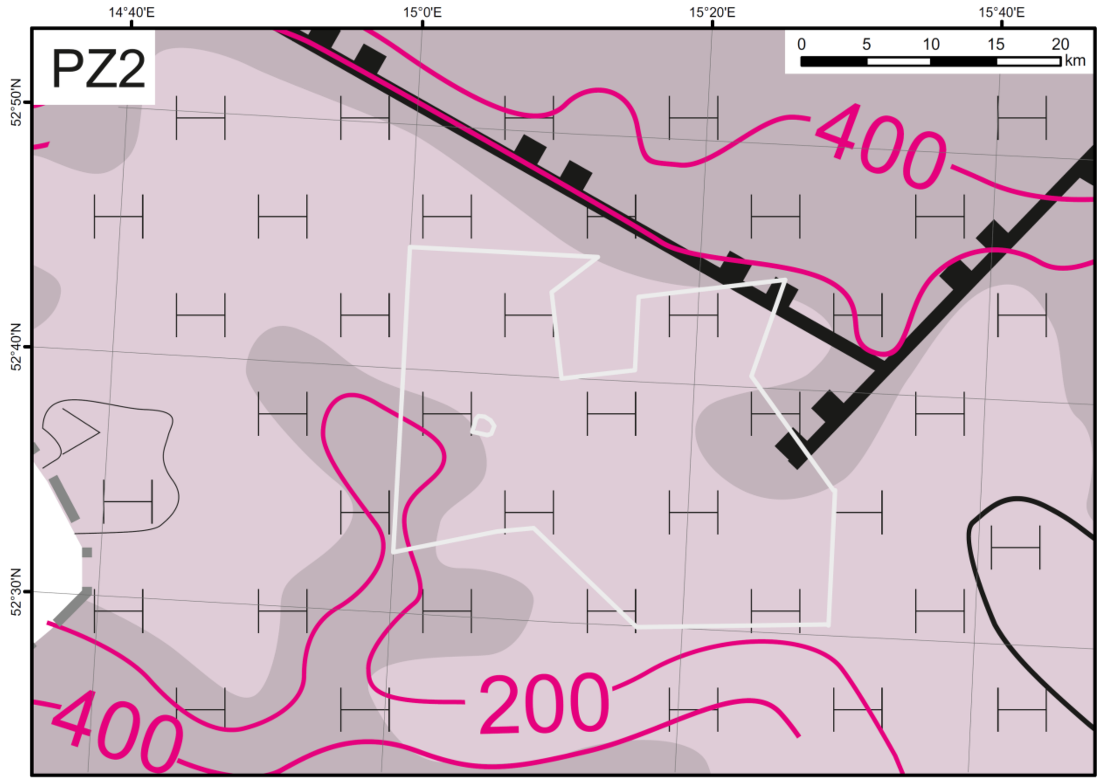


Fig. 2.24. Location of the "Gorzów Wielkopolski S" tender area on the PZ2 cyclothem palaeogeographic-thickness map (Wagner, 1998; modified).

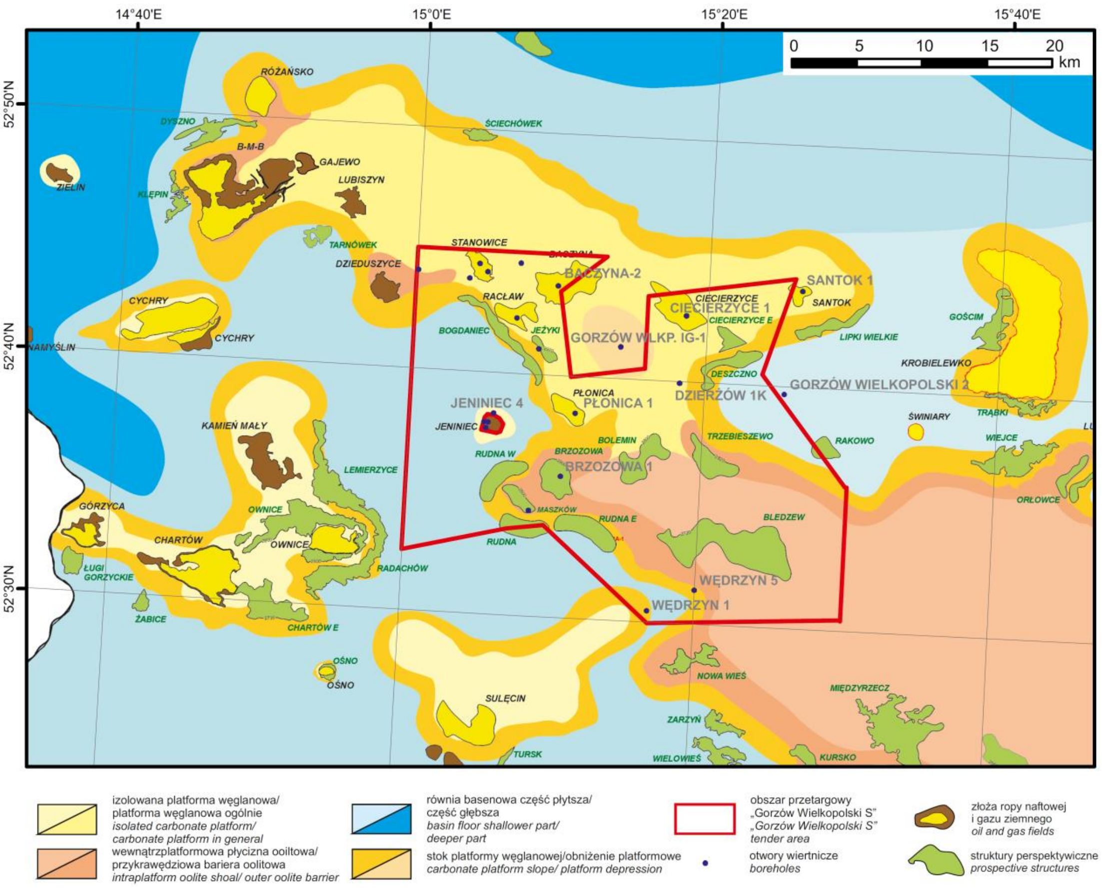


Fig. 2.25. Main Dolomite palaeogeography, oil and gas fields and prospective structures (Buniak et al., 2013b; modified) with location of the "Gorzów Wielkopolski S" tender area.

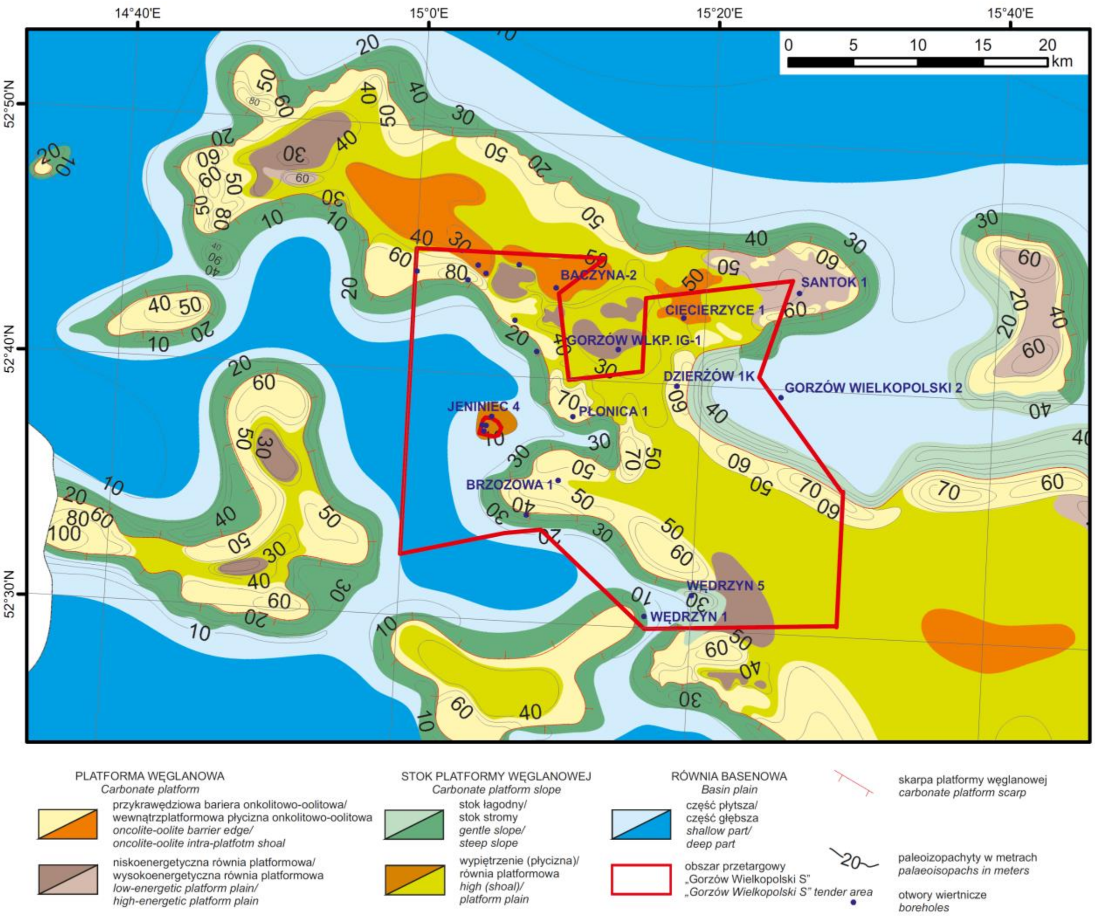


Fig. 2.26. Main Dolomite palaeogeography and thickness (Wagner, 2012; modified) with location of the "Gorzów Wielkopolski S" tender area.

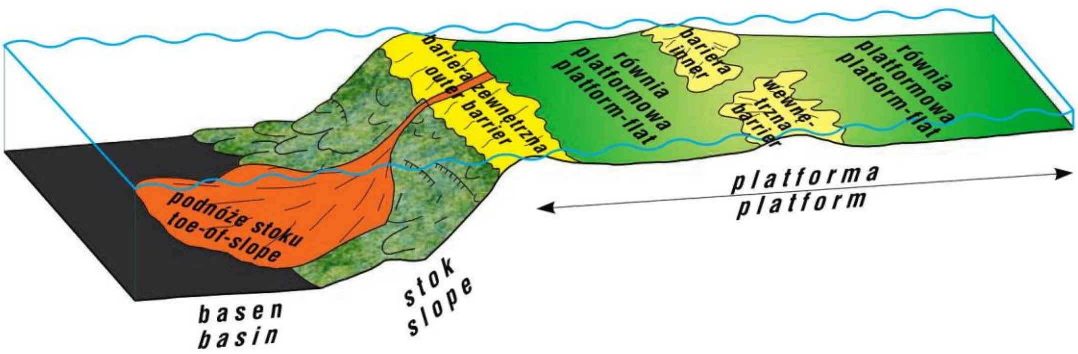


Fig. 2.27. Depositional architecture of the Main Dolomite in the Międzychód area during HST (Jaworowski and Mikołajewski, 2007, in Czekański et al., 2010; modified).

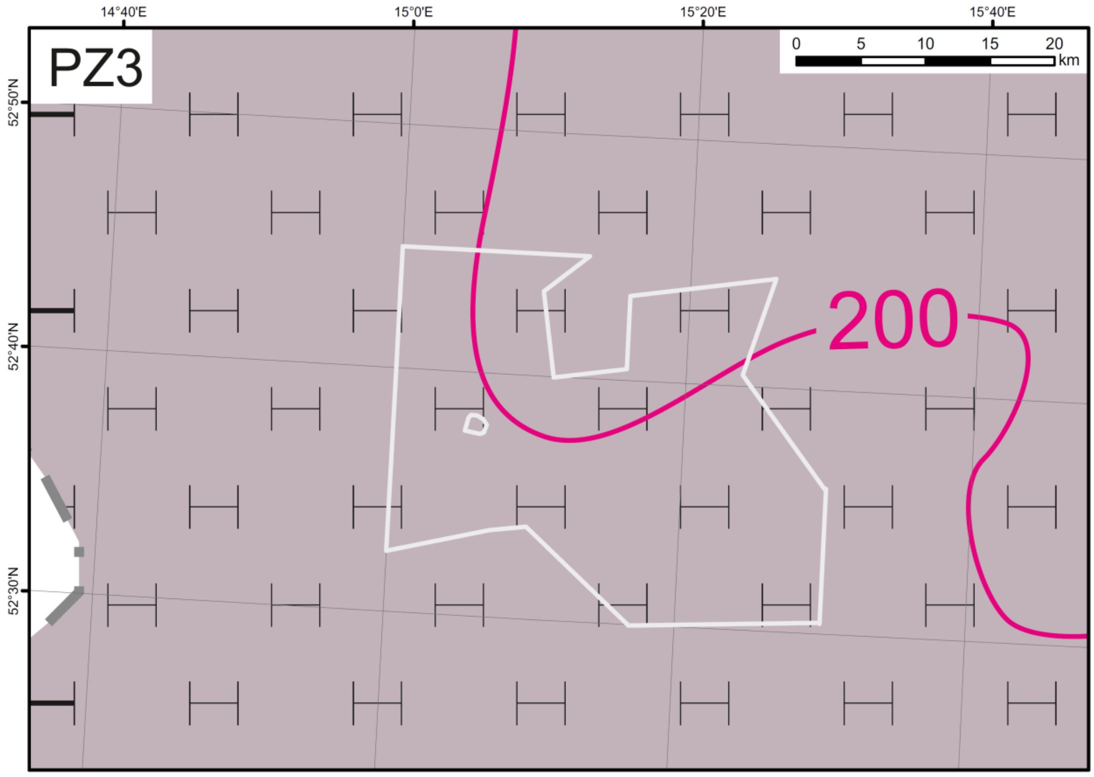


Fig. 2.28. Location of the "Gorzów Wielkopolski S" tender area on the PZ3 cyclothem palaeogeographic-thickness map (Wagner, 1998; modified).

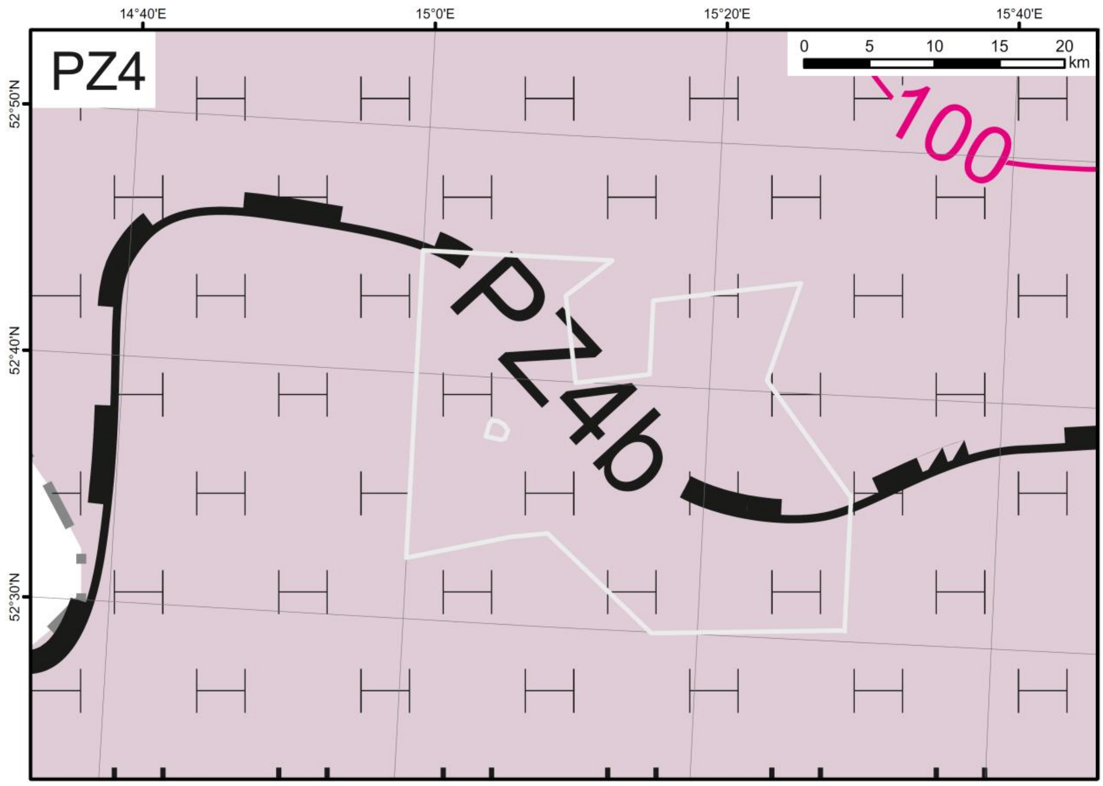


Fig. 2.29. Location of the "Gorzów Wielkopolski S" tender area on the PZ4 cyclothem palaeogeographic-thickness map (Wagner, 1998; modified).

Lithostratigraphy		Depth (thickness) [m]								
		Baczyna-2	Jeniniec 4	Racław 1K	Stanowice 3	Wędrzyn 1	Wędrzyn 5	Dzierżów 1K	Dzierżów 1K-BIS	Ciecierzyce 1K
PZ4 cyclothem		**67.0**	**78.5**	**70.0**	**92.5**	**48.0**	**51.0**	**56.54**	**56.01**	**58.5**
PZ3 cyclothem		**192.5**	**194.0**	**215.0**	**213.5**	**163.0**	**159.5**	**287.69**	**253.11**	**>184.0**
Na3	Younger Halite	2756.0–2920.0 (164.0)	2451.0–2608.5 (157.5)	2807.0–2977.0 (170.0)	2818.5–3007.0 (188.5)	2409.0–2525.0 (116.0)	2442.0–2580.5 (138.5)	2587.97–2769.66 (181.69)	2589.15–2744.53 (155.38)	2679,0–2835,5 (>156,5)
A3	Main Anhydrite	2920.0–2946.0 (26.0)	2608.5–1643.0 (34.5)	2977.0–3020.0 (43.0)	3007.0–3029.0 (22.0)	2525.0–2568.0 (43.0)	2580.5–2607.5 (27.0)	2769.66–2849.48 (99.82)	2744.53–2839.77 (95.24)	2835,5–2861,0 (25,5)
T3	Grey Pelite	2946.0–2948.0 (2.0)	2643.0–2645.0 (2.0)	3020.0–3022.0 (2.0)	3029.0–3032.0 (3.0)	2568.0–2572.0 (4.0)	2607.5–2611.5 (4.0)	2849.48–2875.66 (6.18)	2839.77–2842.26 (2.49)	2861,0–2863,0 (2,0)
PZ2 cyclothem		**171.5**	**359.0**	**194.5**	**195.2**	**340.0**	**350.5**	**117.71**	**146.55**	**>144.0**
A2r	Screening Anhydrite	2948.0–2950.0 (2.0)	2645.0–2648.5 (3.5)	3022.0–3024.5 (2.5)	3032.0–3034.0 (2.0)	2572.0–2575.0 (3.0)	–	2875.66–1876.55 (0.89)	2842.26–2848.24 (5.98)	2863,0–2864,5 (1,5)
Na2r	Screening Older Halite	–	–	–	–	–	–	–	–	–
K2	Older Potash	–	–	3024.5–3034.0 (9.5)	3034.0–3065.0 (31.0)	–	–	–	–	–
Na2	Older Halite	2950.0–3060.5 (110.5)	2648.5–2987.5 (339.0)	3034.0–3102.5 (68.5)	3065.0–3113.0 (48.0)	2575.0–2894.0 (319.0)	2613.5–2903.0 (289.5)	2876.55–2932.32 (55.77)	2848.24–2928.0 (79.76)	2864.5–2994.5 (130.0)
A2	Basal Anhydrite	3060.5–3066.5 (6.0)	2987.5–3003.5 (16.0)	3102.5–3122.0 (19.5)	3113.0–3133.0 (20.2)	2894.0–2906.0 (12.0)	2903.0–2912.0 (9.0)	2932.32–2937.76 (5.44)	2928.00–2946.94 (18.94)	2994.5–1998.5 (4.0)
Ca2	***Main Dolomite***	***3066.5–3119.5 (53.0)***	***3003.5–3004.0 (0.5)***	***3122.0–3216.5 (94.5)***	***3133.2–3227.2 (94.0)***	***2906.0–2912.0 (6.0)***	***2912.0–2964.0 (52.0)***	***2937.76–2993.37 (55.61)***	***2946.94–2988.81 (41.87)***	***2998.5–3007.0 (>8.5)***
PZ1 cyclothem		**>47.5**	**257.5**	**>39.5**	**>33.8**	**229.0**	**193.5**	**>38.5**	**>45.33**	**–**
A1g	Upper Anhydrite	3119.5–3167.0 (>47.5)	*3004.0–3260.5 (256.5)	3216.5–3256.0 (>39.5)	3227.2–3261.0 (>33.8)	2912.0–3023.0 (111.0)	2964.0–3034.0 (70.0)	2993.37–3031.87 (38.5)	2988.81–3034.14 (>45.33)	–
Na1	Oldest Halite	–	–	–	–	3023.0–3062.0 (39.0)	3034.0–3082.0 (48.0)	–	–	–
A1d	Lower Anhydrite	–	–	–	–	**3062.0–3139.0 (77.0)	**3082.0–3154.5 (72.5)	–	–	–
Ca1 + T1	Zechstein Limestone and Kupferschiefer	–	3260.5–3261.5 (1.0)	–	–	3139.0–3141.0 (2.0)	3154.5–3157.5 (3.0)	–	–	–
Zechstein thickness		**>478.5**	**889.0**	**>519.0**	**>535.0**	**780**	**754.5**	**>500.44**	**>501**	**>386.5**

Tab. 2.1. Depth and thickness of the Zechstein deposits in wells located in the Gorzów Wielkopolski S tender area. *A1d+A1g, **with Oldest Lower Halite (5.5; 4.0) and Middle Anhydrite (24.0; 24.0).

2.2.4. TRIASSIC

Extent and thickness

The thickness of the Triassic succession in the "Gorzów Wielkopolski S" tender area generally does not exceed 1500 m. Only in the Racław 1K well, a greater thickness (1585.5 m) was found. The Triassic was drilled in 18 wells at depths:

- Baczyna 1: information restricted,
- Baczyna-2: 1224.0–2689.0 m,
- Brzozowa 1: information restricted,
- Ciecierzyce 1/1K: 1150.0–2620.5 m,
- Dzierżów 1K: 1091.0–2552.5 m,
- Jeniniec 4: 960.5–2372.5 m,
- Jeżyki 1: information restricted,
- Lubno 1: information restricted,
- Maszków 1: information restricted,
- Płonica 1: information restricted,
- Racław 1K: 1146.5–2732.0 m,
- Stanowice 1: information restricted,
- Stanowice 2: information restricted,
- Stanowice 3: 1247.0–2726.0 m,
- Wędrzyn 1: 923.0–2361.0 m,
- Wędrzyn 5: 954.0–2391.0 m.

Due to the lack of petroleum potential, the Triassic deposits are not described in detail in this report.

2.2.5. JURASSIC, CRETACEOUS AND CENOZOIC

The thickness of the Jurassic succession in the "Gorzów Wielkopolski S" tender area varies from 339.0 (Jeniniec 4 well) to 407.0 m (Dzierżów 1K well). The Jurassic was recognized in the same wells as in the Triassic example.

The Lower Cretaceous thickness in the "Gorzów Wielkopolski S" tender area does not exceed a dozen of meters, while the Upper Cretaceous reaches 700 m.

The thickness of the Cenozoic deposits in the "Gorzów Wielkopolski S" tender area is from about 170.0 m to 245.0 m. The Cenozoic succession in the "Gorzów Wielkopolski S" tender area is represented by Paleogene (Oligocene), Neogene (Miocene) and Quarternary (Pleistocene and Holocene) sediments. A significant part of the tender area is covered by the Holocene aeolian sands forming numerous dunes. There are also sands, silts and river clays of floodplain terraces, as well as river sands and glacial sands over the floodplain terraces (Romanek, 1996; Trela, 2000; Piotrowski and Sochan, 2002; Multan, 2003).

Due to the lack of petroleum potential, the Jurassic, Cretaceous and Cenozoic deposits are not described in detail in this report.

2.3. HYDROGEOLOGY

The "Gorzów Wielkopolski S" tender area is located in the River Warta valley, covering part of the Gorzów Wielkopolski City. It is located at the border of three water regions, several water balance units and six groundwater body units (Figs 2.30–2.31).

The main aquifer used for water supplies is located in the Quaternary deposits, while the Neogene deposits are used only locally. The Quaternary deposits are multilayered and occur as an upper layer located in the River Warta Valley area, the old Toruń-Eberswalde Valley and in highlands. There are also deeper Quaternary water-bearing horizons, located between and underneath clay deposits.

Groundwater levels are most commonly found in fluvioglacial deposits located in valley structures of the Warta River, Odra River and partly Noteć River, as well as in old valley areas. They occur at small depths (up to 5 m b.g.l.) and are usually devoid of isolating sediments. The thickness of the water-bearing zones ranges usually from 10 to 40 meters and only locally it exceeds 50 m. The potential capacity of wells varies from 30 to over 120 m^3/h.

Deeper water-bearing horizons located between clay deposist are found mainly in topographically higher areas, where up to four water horizons can be foud. These are variable in the range, hydrogeological parameters, and degree of isolation.

The main water-bearing zone used for human consumption is located at a depth of ca. 20.0 m to 60.0 m b.g.l. Its thickness reaches 50 m. Deeper water-bearing zones, also classified as usable for human consumption, occur at depths of 120–150 m and have a thickness of about 20 m.

The deppest water-bearing horizon located underneath clay deposits is of less importance. It is usually associated with the River Warta Valley and is found at a depth of about 110–150 m b.g.l. The thickness of this horizon is about 40 m.

Apart from the Quaternary water-bearing horizons, water is also found in fine- and medium-grained sands, silts and lignite deposits of Miocene age. These can be locally connected with the Quaternary deposits. They usualy occur at depths greater than 20 m b.g.l. and their average thickness is more than 40 meters. Water from these deposits is exploited by the town of Lubniewice.

The degree of groundwater vulnerability of the main groundwater aquifer has been described as very high and high in the Warta River Valley. In the rest of the area, the groundwater vulnerability has been defined as medium to low (mainly in the south-east and north-west areas of the tender area).

Within the "Gorzów Wielkopolski S" tender area, there is a small part of the main groundwater reservoir GZWP No. 138 Pradolina Toruńsko-Eberswaldzka. There are several tens of groundwater intakes that abstract water from the main groundwater quifer. Their locations are constrained by the presence of large urban-industrial units.

Only one protection zone for the groundwater intake Siedlice has been established so far. This water intake provides water for Gorzów Wielkopolski. There are numerous restrictions on land use and investments within the boundaries of the protection zone.

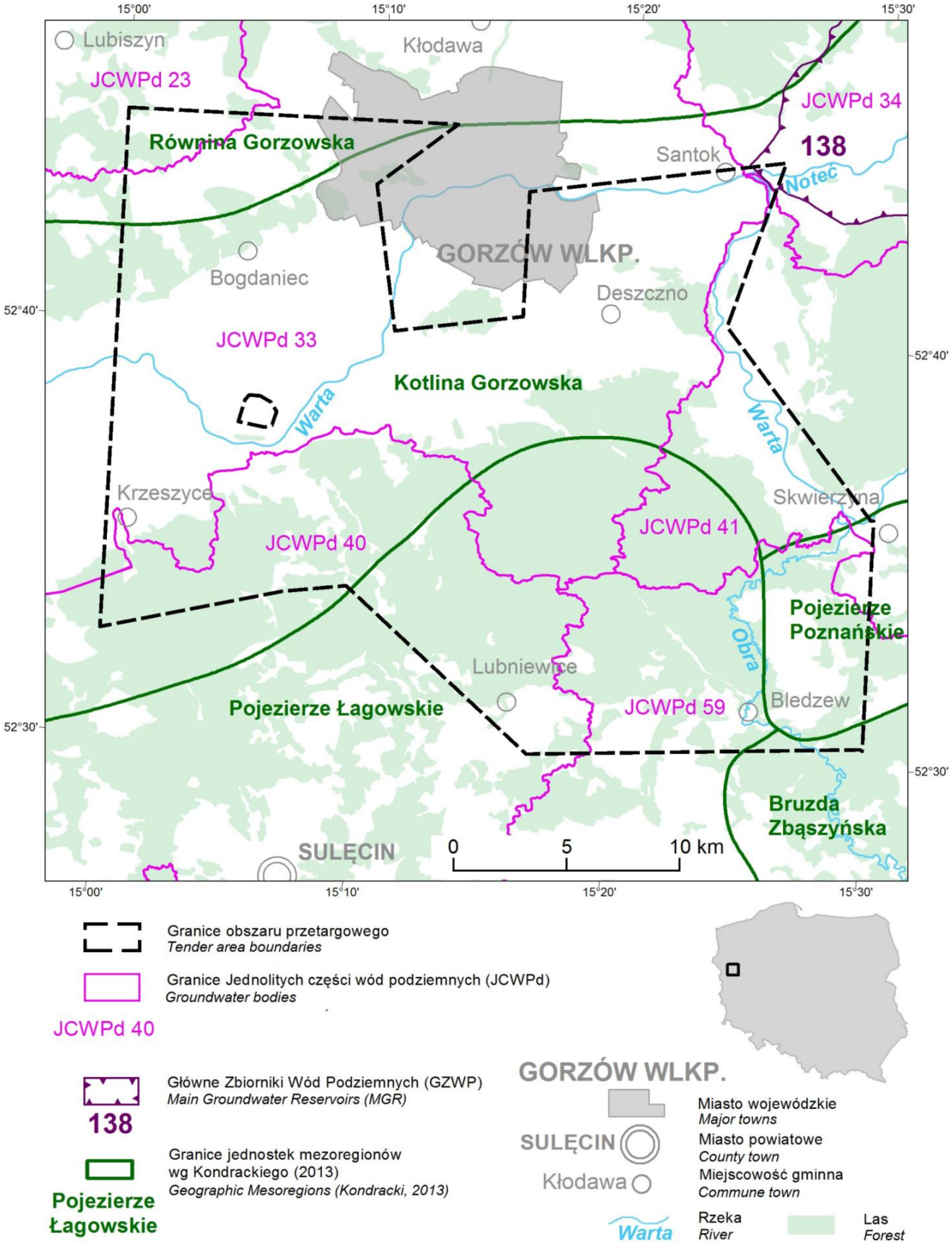


Fig. 2.30. Location of the "Gorzów Wielkopolski S" tender area on the map of the geographic regions, main groundwater reservoirs, and groundwater bodies.

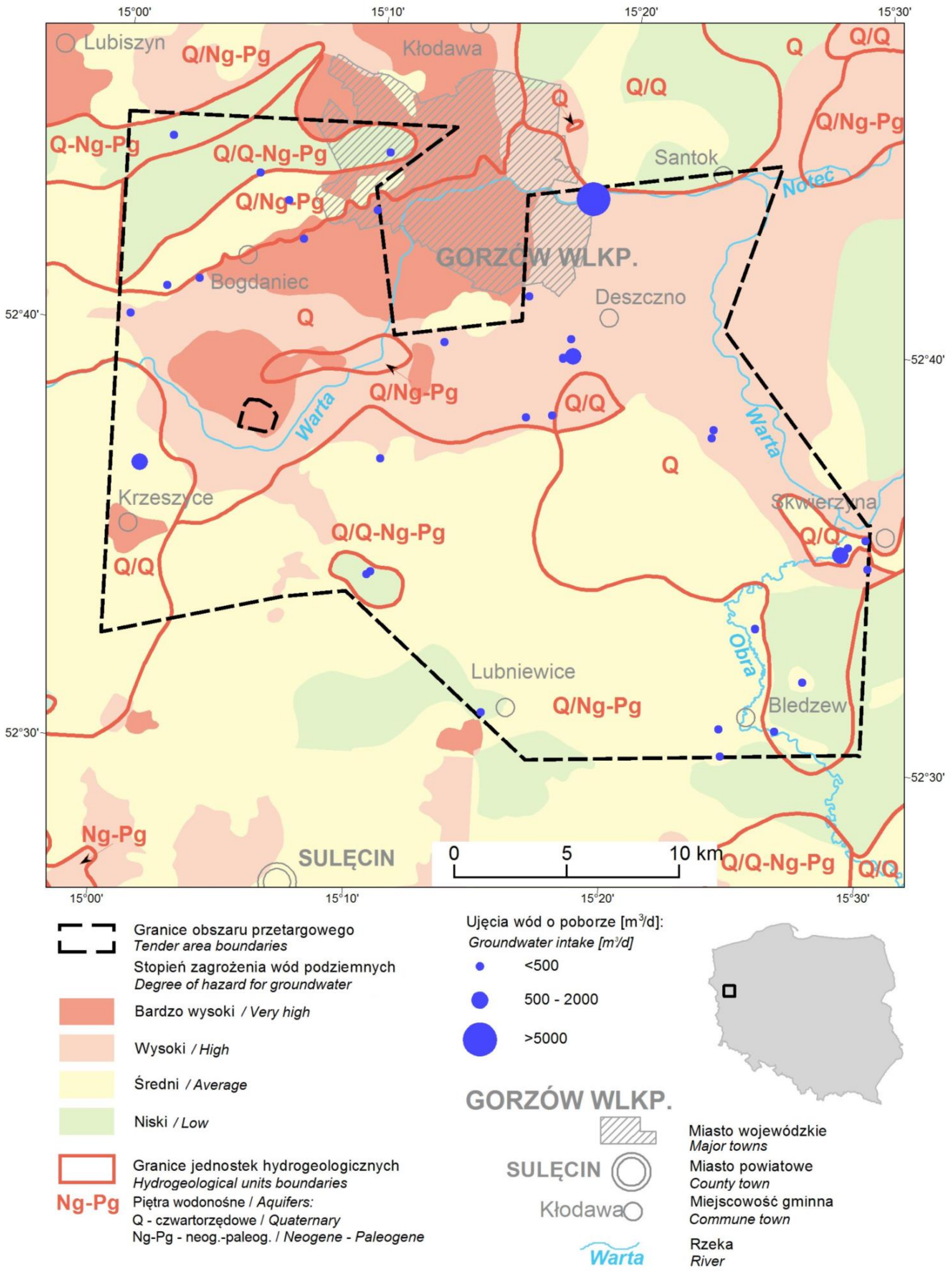


Fig. 2.31. Location of the "Gorzów Wielkopolski S" tender area in relation to the hydrogeological unit boundaries.

3. PETROLEUM PLAY
3.1. GENERAL CHARACTERISTICS

The petroleum play is defined as the set of geological and petroleum processes leading to the formation of a hydrocarbon field. The petroleum play includes source rocks, reservoir rocks, and seal rocks. In addition, an essential element of the petroleum play in conventional accumulations is a trap, which, due to its structural, stratigraphic, lithological and tectonic features, creates a place of accumulation of hydrocarbons. The existence of a petroleum play and the formation of a hydrocarbon reservoir require a set of processes located in space, as well as in geological time, consisting of generation, expulsion, migration and accumulation of hydrocarbons and formation of a reservoir trap. The temporal interrelationships between the mentioned elements and processes of the petroleum play allow the formation of oil and gas fields.

The geology and tectonic of the "Gorzów Wielkopolski S" tender area and petroleum parameters of the Zechstein succession allow to distinguish one petroleum play developed within the Main Dolomite horizon (Fig. 3.1). Although, some indications point the Carboniferous-Permian petroleum play works as well in the region, its characteristics need further investigations.

The petroleum play related to the Main Dolomite is independent, isolated from the base and top by the Zechstein evaporites. From among the basic elements of the petroleum play, both source and reservoir rocks occur in the Main Dolomite unit (Kotarba and Wagner, 2007; Waśkiewicz and Kiersnowski, 2020).

Currently, the source rocks in the Main Dolomite horizon are considered to be of microbial origin (algae and cyano-bacteria; Kotarba and Wagner, 2007), which occur as (1) compact complexes associated with microbial-algal structures and mudstone layers, and (2) dispersed laminas that stabilize grains in laminated sediments (Kotarba and Wagner, 2007; Słowakiewicz and Mikołajewski, 2011; Słowakiewicz and Gąsiewicz, 2013; Waśkiewicz and Kiersnowski, 2020). Earlier, the Main Dolomite basin plain facies were considered to be the source rocks, but, as it was pointed out by Waśkiewicz and Kiersnowski (2020), these rocks have negligible organic matter content (less than 0.3% TOC by weight), very small thicknesses (less than 10 m), high thermal maturity of organic matter (greater than 1.4% Ro), submergence to a depth of about 4 km, and their position determined a long migration path to the reservoir rocks.

Dolomitized grainstones and packstones are primary reservoir rocks in the Main Dolomite petroleum play.

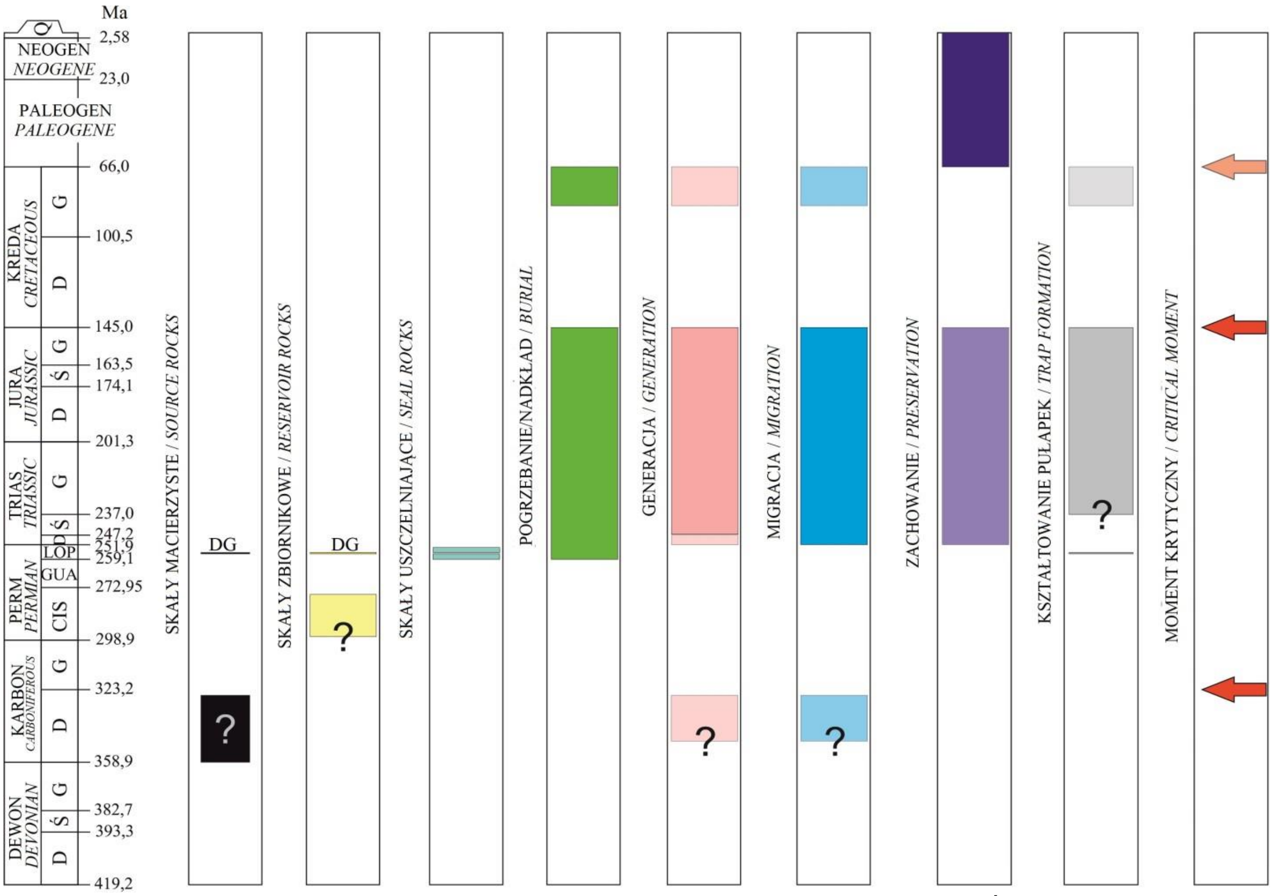


Fig. 3.1. Petroleum play scheme for the "Gorzów Wielkopolski S" tender area. D – Lower, Ś – Middle, G – Upper, CIS – Cisuralian, GUA – Guadalupian , LOP – Lopingian, Q – Quaternary; reservoir rocks: normal color – conventional, brightened color – unconventional; other cases: normal color – certain elements of the petroleum play, brightened color – secondary or less certain elements of the petroleum play (including Lower Permian).

3.2. SOURCE ROCKS

Main Dolomite (Ca2)
Lithology: mudstones, boundstones, packstones, grainstones

The potential source rocks in the Main Dolomite in the "Gorzów Wielkopolski S" tender area occur in the shallow-water carbonate platform and deep-water platform slope and basin plain sediments.

The source rocks related to the Main Dolomite carbonate platform environments are related to the inner and outer barrier slopes and to a lesser extent to the platform plain and barrier zone elevations (Figs 2.25–2.27; Wagner, 2004; Kotarba and Wagner, 2007; Czekański et al., 2010). The tender area covers the southeastern and central parts of the Gorzów Platform, including the southern part of the Santok Peninsula, and the northwestern part of the Wielkopolska Platform, including almost the entire Maszków Peninsula (Figs 2.25–2.26; Wagner, 1994, 2004; Wagner et al., 2000). The thickness of the rocks considered as a source for hydrocarbons usually does not exceed 15 m, which is less than 20% of the total thickness of the Main Dolomite succession. A lower thickness was found within the elevations of the barrier zones, and the greatest thickness (up to about 25 m) was observed in the inner and outer slopes of the barriers (Kotarba and Wagner, 2007). Microfacies variation in these rocks is very high (grainstones, packstones, wakstones, mudstones, rudstones, boundstones). Biostructures, including biolaminations and microbial mats, as well as stromatolites and algal thrombolites, are common as well (Wagner et al., 2000; Kotarba and Wagner, 2007; Jaworowski and Mikolajewski, 2007).

Source rocks related to the deeper environments occur within the slope of carbonate platforms and bays of the basin plain (Witnica Bay, Noteć Bay; Figs 2.25–2.26; Wagner, 1994, 2004; Wagner et al., 2000). The greatest thickness of source rock is found within the slopes of the platforms, where it can reach up to 30 m and represent more than 50% of the Main Dolomite succession thickness. The slopes of the carbonate platform are developed as packstones alternating with floatstones, and more rarely, rudstones formed from redeposited material. Interbeds of biolaminated, dolomitic and limestone mudstones are present in some cases. In basin plain bays, the Main Dolomite is up to 30 m thick, and in some areas (e.g. in the Gorzów Wielkopolski 2 well), the source rocks cover the entire thickness of the succession (Kotarba and Wagner, 2007). The basin plain source rocks are represented by laminated mudstones with microbial layers (Wagner et al., 2000; Kotarba and Wagner, 2007; Jaworowski and Mikołajewski, 2007).

The results of the Rock-Eval pyrolysis and group bitumen composition in individual microfacies in the Main Dolomite of the Gorzów Block and the western part of the Noteć Bay are given in Tab. 3.1 (after Kosakowski and Krajewski, 2015). The concurrent content of dispersed organic matter (TOC) in the Gorzów Block is relatively low and ranges mostly between 0.01 and 1.0% by weight, (Wojtysiak and Chruścińska, 2013; Solarska, 2003; Zielińska-Pikulska, 2003a; Kotarba and Wagner, 2007; Kosakowski and Krajewski, 2015). The original TOC content (TOC 0) ranged between 1 and 5% by weight. Kotarba and Wagner (2007), who investigated the organic geochemistry of the Main Dolomite in the Gorzów Block in numerous wells (including Baczyna-2, Ciecierzyce 1, Dzierżów 1K, Gorzów Wielkopolski 2, Gorzów Wielkopolski IG-1, Jeżyki 1, Stanowice 2 and 3 wells), stated the type II kerogen predominated in the Main Dolomite, and admixtures of type I and III kerogen are also prestent. Numerous geochemical studies from Poland and Germany confirm the typically marine origin and oil-forming nature of the organic matter in the Main Dolomite (e.g. Kotarba et al., 2000a, b; Hammes et al., 2013; Słowakiewicz et al., 2018). According to Kosakowski and Krajewski (2015), bitumens from the Gorzów Platform and Noteć Bay are mainly epigenetic. An increased portion of syngenetic bitumen in this region occurs in slope facies. The dominance of migrated hydrocarbons is also indicated by the results of pyrolysis of the Main Dolomite samples in the Baczyna-2, Ciecierzyce 1, Racław 1K and Stanowice 3 wells (Wojtysiak and Chruścińska, 2013; Solarska, 2003; Zielińska-Pikulska, 2003a).

The vitrinite reflectance (Ro) in the Main Dolomite is relatively uniform in the “Gorzów Wielkopolski S” tender area, ranging between 1.06 and 1.40%, which corresponds to the final stage of the oil window and the beginning of the gas window. The received Tmax values range between 432˚C and 482˚C (Kotarba and Wagner, 2007; Kosakowski and Krajewski, 2015), indicating thermal maturity at the middle and late oil window level, locally being higher.

The Main Dolomite of the Gorzów Block area has a poor to medium potential for hydrocarbon generation. Source rocks with good and excellent hydrocarbon potential occur probably only locally in isolated intervals (e.g. Kotarba et al., 2000a, b; Wagner, 2004; Kosakowski and Krajewski, 2015), and they have not been drilled so far in the tender area. Heating conditions and the type of organic material indicate the Main Dolomite is likely a source of liquid and, to a minor extent, gaseous hydrocarbons.

Index/Microfacies	I	II	III	V	VI	VII
Total organic carbon (TOC) *(wt. %)*	0.02 to 0.66 (20) / 0.27 (2)	0.00 to 0.71 (43) / 0.83 (3)	0.04 to 1.19 (29) / 0.19 (4)	0.02 to 2.85 (94) / 0.26 (8)	0.27 and 0.25 (1)	0.04 to 0.55 (30) / 0.19 (8)
$S_1 + S_2$ *(mg HC/g rock)*	0.17 to 0.92 (12) / 0.48 (2)	0.17 to 0.96 (31) / 0.28 (2)	0.10 to 8.22 (4) / 2.33 (3)	0.13 to 9.02 (40) / 2.09 (7)	1.22 and 1.30 (1)	0.08 to 1.53 (15) / 0.67 (5)
Hydrogen index (HI) *(mg HC/g TOC)*	15 to 168 (12) / 83 (2)	5 to 61 (31) / 28 (2)	7 to 152 (4) / 73 (3)	12 to 270 (40) / 123 (7)	89 and 104 (1)	8 to 231 (15) / 76 (5)
Oxygen index (OI) *(mg CO_2/g TOC)*	12 to 259 (21) / 49 (2)	9 to 490 (31) / 82 (2)	39 to 270 (4) / 122 (3)	11 to 496 (40) / 250 (7)	85 and 88 (1)	100 to 418 (15) / 183 (5)
T_{max} (°C)	454 to 558 (7) / 530 (2)	–	–	402 to 456 (11) / 442 (4)	–	–
Production index *(PI)*	0.17 to 0.75 (12) / 0.41 (2)	0.35 to 0.91 (31) / 0.67 (2)	0.28 to 0.85 (4) / 0.61 (3)	0.15 to 0.89 (40) / 0.63 (7)	0.80 and 0.80 (1)	0.15 to 0.83 (15) / 0.69 (5)
Bitumens *(ppm)*	290 to 960 (8) / 540 (1)	240 to 350 (6) / 285 (2)	200 to 9660 (11) / 1140 (2)	30 to 8740 (101) / 1280 (6)	–	290 to 2240 (3) / 285 (3)
Aromatics HC *(%)*	23 to 25 (3) / 24 (1)	26 to 38 (4) / 33 (2)	10 to 23 (7) / 16 (2)	10 to 32 (28) / 17 (5)	–	12 and 30 (2)
Saturated HC *(%)*	12 to 18 (3) / 16 (1)	15 to 34 (4) / 18 (2)	24 to 72 (7) / 36 (2)	16 to 87 (28) / 49 (5)	–	17 and 47 (2)
Resins *(%)*	16 to 38 (3) / 24 (1)	21 to 30 (4) / 26 (2)	4 to 29 (7) / 23 (2)	7 to 25 (28) / 16 (5)	–	7 and 27 (2)
Asphaltenes *(%)*	27 to 42 (3) / 36 (1)	12 to 32 (4) / 23 (1)	10 to 42 (7) / 25 (2)	1 to 48 (28) / 17 (5)	–	28 to 34 (2)

Index/Facies	VIII	IX	XI	XII	XV
Total organic carbon (TOC) *(wt. %)*	0.01 to 0.75 (32) / 0.16 (4)	0.03 to 2.32 (74) / 0.34 (8)	0.02 to 3.82 (54) / 0.34 (6)	0.14 and 0.78 (2)	0.02 to 0.90 (9) / 0.83 (6)
$S_1 + S_2$ *(mg HC/g rock)*	0.08 to 7.14 (7) / 1.39 (2)	0.05 to 19.31 (45) / 2.45 (7)	0.05 to 9.24 (47) / 2.38 (5)	6.91	0.54 to 1.60 (6) / 0.28 (3)
Hydrogen index (HI) *(mg HC/g TOC)*	16 to 172 (5) / 71 (2)	53 to 304 (45) / 130 (7)	4 to 243 (47) / 123 (5)	126	57 to 148 (6) / 95 (3)
Oxygen index (OI) *(mg CO_2/g TOC)*	149 to 376 (4) / 239 (2)	24 to 440 (45) / 146 (7)	7 to 391 (45) / 146 (7)	–	30 to 126 (6) / 82 (3)
T_{max} (°C)	402 and 409 (1)	404 to 443 (11) / 428 (3)	404 to 443 (11) / 428 (3)	–	439 and 442 (1)
Production index *(PI)*	0.64 to 0.88 (7) / 0.77 (2)	0.23 to 0.89 (45) / 0.67 (7)	0.23 to 0.89 (45) / 0.67 (7)	0.86	0.48 to 0.83 (6) / 0.69 (3)
Bitumens *(ppm)*	150 to 8470 (7) / 1570 (2)	240 to 14730 (20) / 3515 (6)	540 to 12610 (35) / 3370 (3)	8500	300 to 1540 (4) / 1115 (4)
Aromatics HC *(%)*	9 to 20 (3) / 15 (2)	11 to 15 (6) / 14 (4)	6 to 26 (20) / 18 (3)	18	12
Saturated HC *(%)*	52 to 68 (3) / 58 (2)	26 to 76 (6) / 46 (4)	40 to 86 (20) / 61 (3)	68	70
Resins *(%)*	6 to 14 (3) / 10 (2)	6 to 15 (6) / 11 (4)	2 to 16 (20) / 9 (3)	4	8
Asphaltenes *(%)*	6 to 25 (3) / 17 (2)	7 to 50 (6) / 40 (4)	2 to 24 (20) / 12 (3)	10	10

Tab. 3.1. The results of Rock-Eval pyrolysis in the Zechstein Main Dolomite of the Gorzów Platform and the western part of the Noteć Bay (Kosakowski and Krajewski, 2015). Parameter explanation: TOC – total organic carbon; Tmax – temperature of maximum of S2 peak; S2 – residual petroleum potential; S1 – oil and gas yield; PI – production index; HI – hydrogen index; OI – oxygen index. Range of geochemical parameters is given as the numerator; average values in the denominator, in parentheses: number of samples from wells (numerator) and number of sampled wells (denominator). Microfacies explanation: I – lime dolomudstone-wackestone (basin, toe-of slope facies with pelagic microfossils); II – microbioclastic–peloid calcisilte dolopackstone and dolomudstone (allochthonous and autochthonous lower and middle slope and toe-of slope facies, interbedded units of calciturbidites and lime-mudstone); III – microbreccia, lithoclastic dolopackstone, grainstone, dolofloatstone, dolomudstone (upper middle steep slope facies slump-breccias, debrites, units of fine grainstone, packstone and lime-mudstones); IV – laminated peloidal dolopackstone, dolobindstone, dolomudstone (low-angle platform slope with microbial peloidal mud-mound facies); V – ooid dolograinstone–packstone (high-energy shallow subtidal platform margin bar/back-bar and inner platform oolitic shoal, upper platform slope facies); VI – micritic ooid dolograinstone packstone (moderate-energy shallow subtidal inner platform oolitic shoal facies); microbial dolobindstone microframestone, dolopackstone (shallow subtidal margin and inner platform microbial reef facies); VIII – oncoid dolopackstone–floatstone (shallow subtidal open-marine inner platform lagoon facies); IX – aggregate-grain, lump, algal dolopackstone, grainstone, dolobindstone (shallow subtidal open/restricted inner platform wide facies, microbial algal–mounds); X – bioclastic–peloidal dolowackestone–mudstone (shallow subtidal protected inner platform facies with moderate–low water circulation); XI – fenestral microbial dolobindstone, dolomudstone, dolopackstone (inner platform tidal flat facies); XII – pisoid dolorudstone–grainstone (meteorically affected (supratidal) shoal and bar facies); XIII – lithoclastic dolorudstone–floatstone, dolopackstone (inner platform lag facies in tidal channels and flats); XIV – poorly laminated micrite, microsparite with evaporitic minerals (inner platform lag facies in tidal channels and flats); XV – laminite evaporite-carbonate dolomudstone and dolobindstone (intertidale supratidal sabkha facies).

3.3. RESERVOIR ROCKS

Main Dolomite

Maximum thickness: 94.5 m in the Racław 1K well and 94 m in the Stanowice 3 well.
Depth to the top: 2906.0 m (Wędrzyn 1 well) – 3133.2 m (Stanowice 3 well).

Based on previous studies of the Main Dolomite in the "Gorzów Wielkopolski S" area, the best reservoir properties are related to the carbonate platform and slope sediments (Jaworowski and Mikołajewski, 2007; Słowakiewicz and Mikołajewski, 2009; Czekański et al., 2010; Kwolek and Mikołajewski, 2010). Some values of petrophysical properties from wells located within the "Gorzów Wielkopolski S" tender area are summarized in Tab. 3.2. The porosity ranges widely from values near 0 to even over 37%, with minimum values measured in the basin mudstones (Jeniniec 4 and Wędrzyn 1 wells). The largest fluctuations in porosity are observed in the carbonate platform sedimens (Figs. 3.2–3.3). The reservoir properties depend on both the initial structural and textural characteristics of the rocks and their diagenetic transformations. In the Stanowice 3 well, the highest porosity is found in grained carbonate platform sediments in different parts of the section. In contrast, the lowest porosity is found in strongly anhydritized slope sediments recognized in the lower part of the section. The latter are characterized by very low or no permeabilities. Nearly no permeability was found in basin facies (Jeniniec 4 and Wędrzyn 1 wells).

In the carbonate platform deposits, permeability is close to zero, and only in some cases the values are higher, occasionally reaching over 100 mD and more, as a result of fracturing. Overall, the average permeability is very low and ranges from 0 in the wells representing the basin facies of the Main Dolomite, to over 3.7 mD in the Ciecierzyce 1K well. Commonly, permeability does not correlate with porosity, which is probably related to the fact that porosity in many cases is microcrystalline.

In the Gorzów Platform and Noteć Bay, Semyrka (2013) recognized three main subfacies in the Main Dolomite: grainstone, mudstone and microbial (boundstones), which are characterized by different petrophysical properties (effective and dynamic porosity). The boundstones were classified as reservoir rocks with low and medium capacity for gas, and very low and low capacity for oil. The muddy sediments are classified as low- to medium-capacity rocks for oil and gas. They are characterized by a pore space system. The reservoir rocks represented by grained facies were classified as of medium, locally high capacities for gas, and low for oil.

The composition of gas collected from the Main Dolomite from wells located within the tender area is highly diverse (Tab. 3.3). Many wells show a significant amount of nitrogen (even up to 94% in the Stanowice 3 well). Still, one should also consider the Wędrzyn 5 or Jeniniec 4 wells, in which the methane content is 40.78 and 73.99%, respectively. The Main Dolomite source rocks often produced also non-hydrocarbon gases such as H_2S, CO_2, and especially N_2 (Pletsch et al., 2010). Nitrogen, which is always a part of the Main Dolomite gas, formed probably from marine organic matter during its thermogenic transformation (Kotarba et al., 2000a). Brine water analyses from 6 wells (Tab. 3.4) indicate that sodium chloride brines and sometimes calcium brines occur in the Main Dolomite in the tender area.

The Main Dolomite in the "Gorzów Wielkopolski S" tender area is represented by dolomitized grainstones and packstones deposited in the shallow-marine carbonate platform environments and its slopes, as well as by micrite limestones (mudstones) deposited in the deeper environment of the basin plain. These rocks were characterized by completely different reservoir properties.

The carbonate platform sediments had initially excellent porosity and permeability, which, however, decreased significantly during diagenesis, mainly due to pore space cementation and chemical compaction. On the other hand, the basin sediments, by their nature, had poor reservoir properties. Dolomitization may have contributed to increased intergranular microporosity, which is not typically correlated with good permeability.

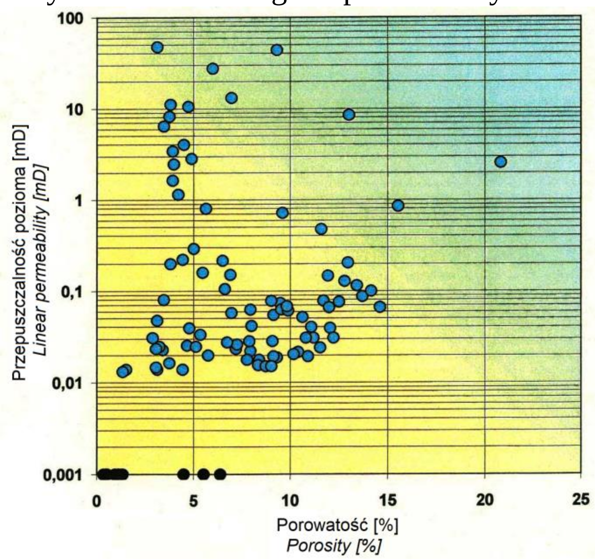


Fig. 3.2. Correlation of horizontal permeability with porosity in the Main Dolomite in the Dzierżów 1K well (Szczawińska, 2003).

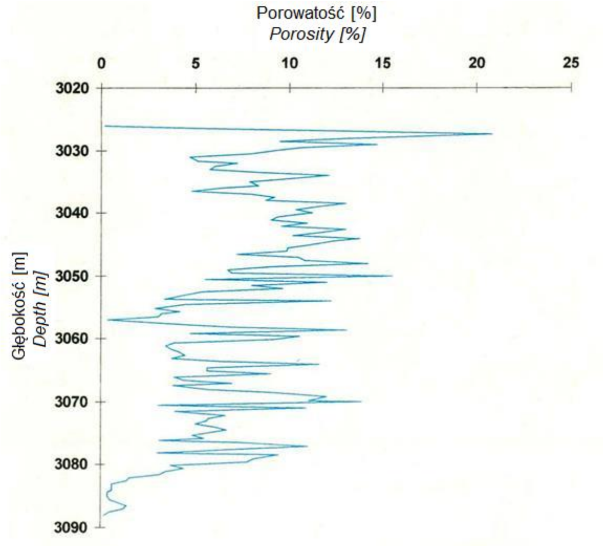


Fig. 3.3. Correlation of porosity vs depth in the Main Dolomite in the Dzierżów 1K well (Szczawińska, 2003).

Wells	Interval [m]	Samples porosity/ permeability	Porosity [%] Min.–Max. (average)	Permeability [mD] Min.–Max. (average)	Bitumen content [%] Min.–Max. (average)
Baczyna-2	3067.0–3112.0	82/75	3.22–37.48 (20.11)	<0.001–>1000 (7.90)	0.017–1.278
Ciecierzyce 1K	3006.65–3114.65	17/14	11.0–24.98 (20.1)	0.023–15.786 (3.74)	0.046–0.690
Dzierżów 1K	3026.05–3088.05	125/101	0.35–20.81 (7.13)	<0.001–152.615 (3.51)	0.009–0.415
Dzierżów 1K-BIS	2952.05–2994.60	86/76	0.67–16.06 (6.74)	<0.001–13.962 (1.50)	0.012–0.429
Jeniniec 4	3004.20–3004.30	1/1	0.37	0.10	–
Racław 1K	3119.0–3214.05	159/153	1.19–34.59 (12.02)	<0.001–39.68	0.003–0.793
Stanowice 3	3132.60–3220.05	182/163	0.7–19.75 (4.72)	<0.001–15.387	0.006–0.725
Wędrzyn 1	2905.75–2924.75	10/10	0–3.8 (1.01)	(0.0)	0.0168–0.1104 (0.0601)
Wędrzyn 5	2912.0–2964.0	–	0.01–16.6 (6.14)	0–19.9 (0.12)	0.0088–0.0956 (0.0305)

Tab. 3.2 Selected petrophysical properties of the Main Dolomite (and sourrounding sediments) in the “Gorzów Wielkopolski S” tender area based on final well reports (see Chapter 5).

Wells	Interval [m]	Gas composition [% vol.]	Comments
Baczyna-2	3068.0–3085.0	**CH_4– 23.93** **C_2H_6–3.10** **C_3H_8–1.27** N_2–66.15 H_2S–2.84	natural gas – gasoline – nitrogen – hydrogen sulfide
	3090.0–3099.0	**CH_4–22.01** **C_2H_6–3.04** **C_3H_8–1.76** N_2–67.20	natural gas – gasoline – nitrogen – hydrogen sulfide

		H_2S–3.79	
Ciecierzyce 1K	3008.0–23017.0	**CH_4–25.98** **C_2H_6**–2.55 **C_3H_8**–1.43 N_2–60.64.84 H_2S–2.97 CO_2–9.17	natural gas – gasoline – nitrogen – hydrogen sulfide
Dzierżów 1K	3024.0–3044.0	**Total hydrocarbons** – **25.81** N_2–74.14 H_2–0.04 CO_2–0.01	natural gas – gasoline – nitrogen
	3024.0–3044.0	**Total hydrocarbons –24.52** N_2–72.15 H_2–0.13 H_2S–2.82 CO_2–0.38	natural gas – gasoline – nitrogen – hydrogen sulfide
Jeniniec 4	2986.0–3010.0	**CH_4–73.99** **C_2H_6**– 0.79 Propan–0.04 N_2–22.48 CO_2–0.04 H_2–2.50	–
	2986.0–3010.0	**CH_4–65.36** **C_2H_6**–1.44 Propan–0.19 N_2–31.52 CO_2–0.13 H_2–1.26	–
Racław 1K	3115.6–3140.0	**Total hydrocarbons – 21.43** N_2–77.55 CO_2–0.22 H_2S–0.80	natural gas – gasoline – nitrogen – hydrogen sulfide
Stanowice 3	3146.0–3183.0	**węglowodory razem 10.92** N_2–86.20 H_2–2.74 CO_2–0.10	natural gas – nitrogen
	3146.0–3183.0	**Total hydrocarbons – 4.70** N_2–94.48 H_2–0.55 CO_2–0.26	natural gas – gasoline – nitrogen
Wędrzyn 1	2906.0–2912.0	**Total hydrocarbons – 11.08** N_2–88.74 H_2–0.08 He–0.02	–
Wędrzyn 5	2912.0–2937.0	**Total hydrocarbons – 40.78** N_2–50.57 H_2–0.50 He–0.06 CO_2–5.86	–

Tab. 3.3. Gas composition in the Main Dolomite (and sourrounding sediments) in the "Gorzów Wielkopolski S" tender area based on final well reports (see Chapter 5).

Wells	Interval [m]	Water chemical composition [g/litr]	Comments
Baczyna 2	3090.0–3099.0	Cl^-–195.0865 Br^-–0.6526 HCO_3^-–1.2810 CO_3^{-2}–0.4200 SiO_3^{2-}–0.9471 SO_4^{2-}–1.5638 NH_4^+–0.4000 Fe^{+3}–0.5469* Ca^{2+}–6.7335 Mg^{2+}–0.2918 Na^+–119.3762**	brine approx. 33% sodium chloride
	3090.0–3099.0	Cl^-–210.0020 Br^-–1.9980 HCO_3^-–1.0980 CO_3^{2-}–0.0000 SiO_3^{2-}–1.2764 SO_4^{2-}–0.7819 NH_4^+–1.2500 Fe^{3+}–0.1174* Ca^{2+}–27.4148 Mg^{2+}–1.8969 Na^+–101.5450**	approx. 35% sodium-chloride brine with a high proportion of bromine and ammonium ions
Racław 1K	3122.0–3131.0	Cl^-–70.1283 Br^-–0.0825 HCO_3^-–1.2932 CO_3^{2-}–0.0000 SiO_3^{2-}–0.1798 SO_4^{2-}–1.1852 NH_4^+–0.2000 Fe^{3+}–0.6828* Ca^{2+}–1.7796 Mg^{2+}–0.5545 Na^+–42.4809**	separator water during the production test - genetic type according to Sulina Cl-Ca, liquid with infiltrate character
Stanowice 3	3177.0–3219.0	Cl^-–202.5497 Br^-–1.3453 HCO_3^-–1.4152 CO_3^{2-}–0.0000 SiO_3^{2-}–0.9598 SO_4^{2-}–0.8642 NH_4^+–0.5500 Fe^{3+}–0.7217* Ca^{2+}–19.6737 Mg^{2+}–13.1783 Na^+–84.1849**	brine approx. 32.5% sodium-chloride-calcium, with a high magnesium content
Stanowice 3	3177.0–3219.0	Cl^-–195.8114 Br^-–1.8781 HCO_3^-–2.0740 CO_3^{2-}–0.0000 SiO_3^{2-}–4.8676 SO_4^{2-}–0.8107 NH_4^+–0.8500 Fe^{3+}–12.5024* Ca^{2+}–23.7156 Mg^{2+}–8.9529 Na^+–70.9720**	brine, ca. 32.5% sodium-chloride-calcium, heavily contaminated with iron ions and hydrocarbons
Wędrzyn 1	2906.0–2912.0	Cl^-–218 Br^-–3.32 HCO_3^-–0.18 CO_3^{2-}–not detected OH^-– not detected	water from the separator – brown unclarified liquid with a layer of white sediment at the bottom

		SiO_2–0.15 SO_4^{2-}–0.41 Fe^{3+}– not detected Ca^{2+}–21.0 Mg^{2+}–31.5 K^+–7.6	

Tab. 3.4. Results of formation water analysis for test intervals in the Main Dolomite and (locally) immediately overlying/underlying deposits in the "Gorzów Wielkopolski S" tender area, based on final well reports (see Chapter 5) Wyniki analiz wody złożowej dla interwałów opróbowujących poziom dolomitu głównego i (niekiedy) utwory bezpośrednio go przykrywające/podścielające na obszarze "Gorzów Wielkopolski S" na podstawie dokumentacji wynikowych (patrz rozdział 5). * – Al^{3+} + Fe^{3+}, ** – Na^+ + K^+

3.4. SEAL

The most important seal rocks for the Main Dolomite horizon are represented by the Zechstein evaporites – anhydrite and salts – of the PZ2, PZ3 and PZ4 cyclothems. Minor importance has a seal formed by thick Triassic clays.

3.5. PETROLEUM GENERATION, MIGRATION, ACCUMULATION, AND TRAPS

Zechstein/Main Dolomite petroleum play

Source rosks: mudstones, boudstones, packstones, grainstones.

Reservoir rocks: dolomitized grainstones and packstones.

Seal: evaporite-anhydrite succession of the PZ1 cyclothem at the base, evporite-anhydrite succession of the PZ2 cyclothem at the top.

Overburden (about 3000 m thick): Zechstein PZ3, PZ4 cyclothems, Mesozoic-Cenozoic succession.

Traps: structural, lithological and mixed.

Age and mechanism of traps generation: It is conjectured that some of the traps in the Main Dolomite may be primary in nature, not deformed by later tectonic movements, as evidenced by the presence of microbial methane accumulation (Kotarba et al., 2000b).

Age and mechanism of hydrocarbon generation, expulsion, migration, and accumulation: The Main Dolomite horizon includes both source and reservoir rocks (Kotarba et al., 2000a, b; Kosakowski and Krajewski, 2015). Hydrocarbon migration occurred over very short distances. The oil and gas are cogenetic, i.e. they were formed by the transformation of the same organic matter (Kotarba et al., 2000a). Initial hydrocarbon generation occurred most likely as early as in the Late Permian, considering bacterial hydrocarbon generation processes and the presence of microbial-derived gas in some of the fields (Kotarba et al., 2000b). The main, early generation phase already started in the Early Triassic (Fig. 3.5). The source rocks of the Main Dolomite across southwestern Poland entered the so-called oil window between the Late Triassic (basin sediments) with burial to about 2000 m, and the Early Jurassic (platform sediments) with burial to about 1800 to 2200 m (Pletsch et al., 2010). According to Karnkowski (2010), the maximum burial of the Zechstein succession on the Gorzów Block reached about 3000 m. Increased heat flow in the Permian and older Mesozoic contributed to the early and rapid maturation of organic matter. The uplift and erosion on the Gorzów Block during the Early Cretaceous stopped the generation of hydrocarbons. The resubmergence of the area in the Late Cretaceous allowed a return to the Late Jurassic thermal conditions (Karnkowski, 2010).

According to Kotarba and Wagner (2007), hydrocarbon generation processes in the "Gorzów Wielkopolski S" area may have followed two pathways. In the first pathway, generation was a one-step process with full hydrocarbon matter generation in the Late Triassic. In the second pathway, generation took place in two stages. Some 80 to 90% of the hydrocarbons generated from kerogen at the end of the Jurassic, and the final generation took place during the post-Cretaceous period. As a result, oil accumulated in traps during the Triassic and Jurassic, and gas saturation of oil fields occurred in the Late Jurassic, while final gas production took place during the Paleogene or Neogene. The hydrocarbons migrated only a few kilometers from the source rocks to the reservoir rocks in the Main Dolomite horizon.

The Main Dolomite oil in the Gorzów Block area was produced from type II oil-forming algal kerogen, which is in the middle to final stages of low-temperature thermogenic processes (Kotarba 2000a, b). According to Kotarba and Wagner (2007), the generation potential of the Main Dolomite source rocks in the Grotów Peninsula, which is located in the vicinity of the "Gorzów Wielkopolski S" tender area, ranges from 12.4 kg HC/m^3 to 80.5 kg HC/m^3 (e.g. in the Lubiatów 1 well it is 28.0 kg HC/m^3 – Fig. 3.6). Expulsion potential varies from 7.6 kg HC/m^3 to 67.8 kg HC/m^3. Generation potential varies from 133 kg HC/m^2 to 2052 kg HC/m^2 – in the Lubiatów 1 well it is 804 kg HC/m^2.

The vast majority of the analyzed gas samples from the Main Dolomite horizon are genetically related to oil produced from type II oil-producing kerogen (Kotarba et al., 2000b). The major part of methane and higher gaseous hydrocarbons were produced in the early (low temperature) phase of thermogenic processes. In some fields, the microbial component of methane is essential (e.g. in the Jeniniec field). The presence of microbial methane indicates that the traps were already formed and sealed at the initial (microbial) stage of transformation of the organic matter of the Main Dolomite. Then, these traps were successively filled with thermogenic hydrocarbons formed at successively higher stages of transformation of the same source substance. The presence of gas inflow from Carboniferous formations, which was produced from type III kerogen at a high-temperature stage of thermogenic processes, cannot be excluded, as is the case in the nearby Sulęcin field (Kotarba et al., 2000b; see Fig. 4.1).

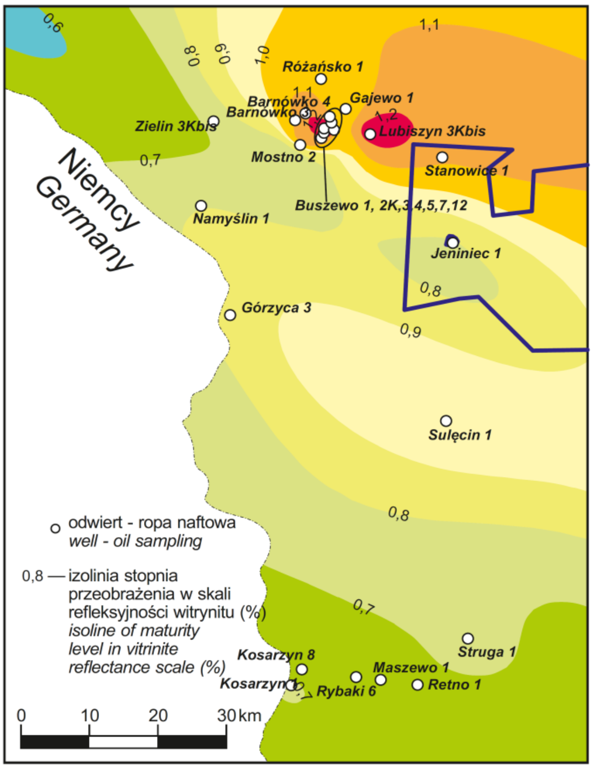


Fig. 3.4. Maturity of organic mater in the Main Dolomite in vitrinite reflectance scale (Kotarba et al., 2000b; modified (in the "Gorzów Wielkopolski S" tender area and its neighborhood.

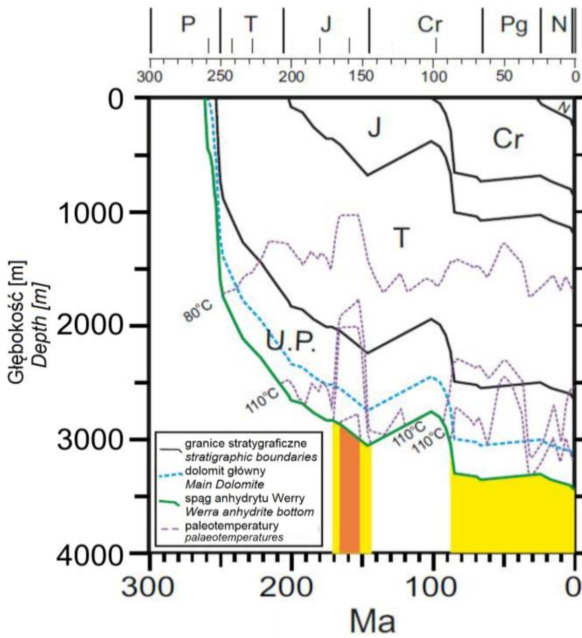


Fig. 3.5. Burial history of the Buszewo 1 and Stanowice 1 wells with PZ1 cyclothem bedrock paleotemperatures represented by yellow values of 12–140°C and orange values of 120–160°C (Kotarba et al., 2020). U.P. – Zechstein, P – Permian, T – Triassic, J – Jurassic, Cr – Cretaceous, Pg – Paleogene, N – Neogene. Location of wells can be found in Fig. 3.4.

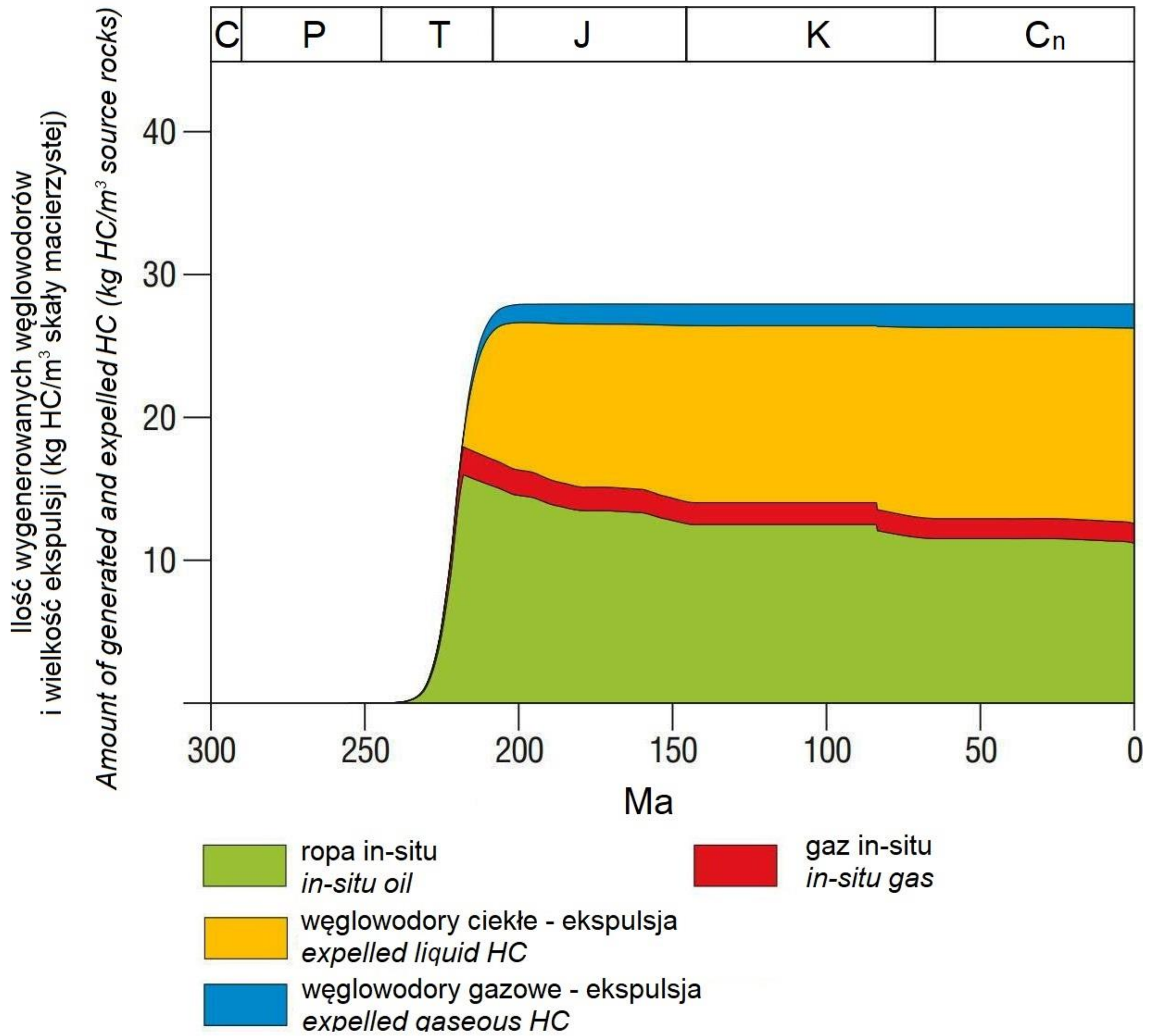


Fig. 3.6. Total amount of generated and expelled hydrocarbons from the Main Dolomite in the Lubiatów 1 well, (Kotarba and Wagner, 2007; modified). C – Carboniferous, P – Permian, T – Triassic, J – Jurassic, K – Cretaceous, Cn – Cenozoic.

4. HYDROCARBON FIELDS

Two hydrocarbon fields kave been documented within the "Gorzów Wielkopolski S" tender area so far (Fig. 4.1). These are:

- Jeniniec crude oil field (NR 4941; Fig. 4.2–4.4, Tab. 4.1);
- Stanowice natural gas field (GZ 9505; Fig. 4.5, Tab. 4.2);

In the close neighborhood of the tender area, two natural gas and crude oil fields have been discovered (Fig. 4.1). These are:

- Dzieduszyce crude oil field (NR 10584; Fig. 4.6–4.8, Tab. 4.3);
- Krobielewko natural gas field (GZ 19116; Fig. 4.9, Tab. 4.4).

The Jeniniec and Dzieduszyce fields are being still exploited.

→ **Fig. 4.1.** Hydrocarbon fields within and in the neighborhood of the "Gorzów Wielkopolski S" tender area.

Obszary wytypowane do postępowania przetargowego na koncesje na poszukiwanie i rozpoznawanie złóż węglowodorów oraz wydobywanie węglowodorów ze złóż w 2021 r.

Areas selected to the tender procedure for concessions for hydrocarbon exploration and production in 2021

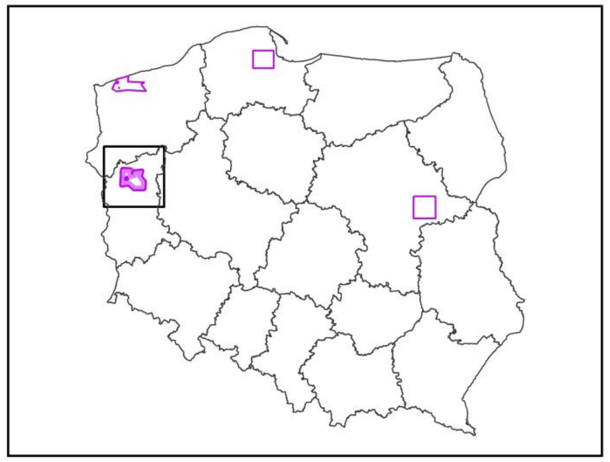
Objaśnienia
Legend

- obszary wytypowane do przetargu / areas selected to the tender procedure
- złoża węglowodorów / hydrocarbon fields
- obszary górnicze / mining areas
- granice gmin / municipalities
- granice powiatów / counties
- granice województw / voivodeships

Współrzędne punktów wyznaczających granice obszaru Gorzów Wielkopolski S, układ współrzędnych PL-1992

Coordinates determining the borders of Gorzów Wielkopolski S tender area, coordinate system PL-1992

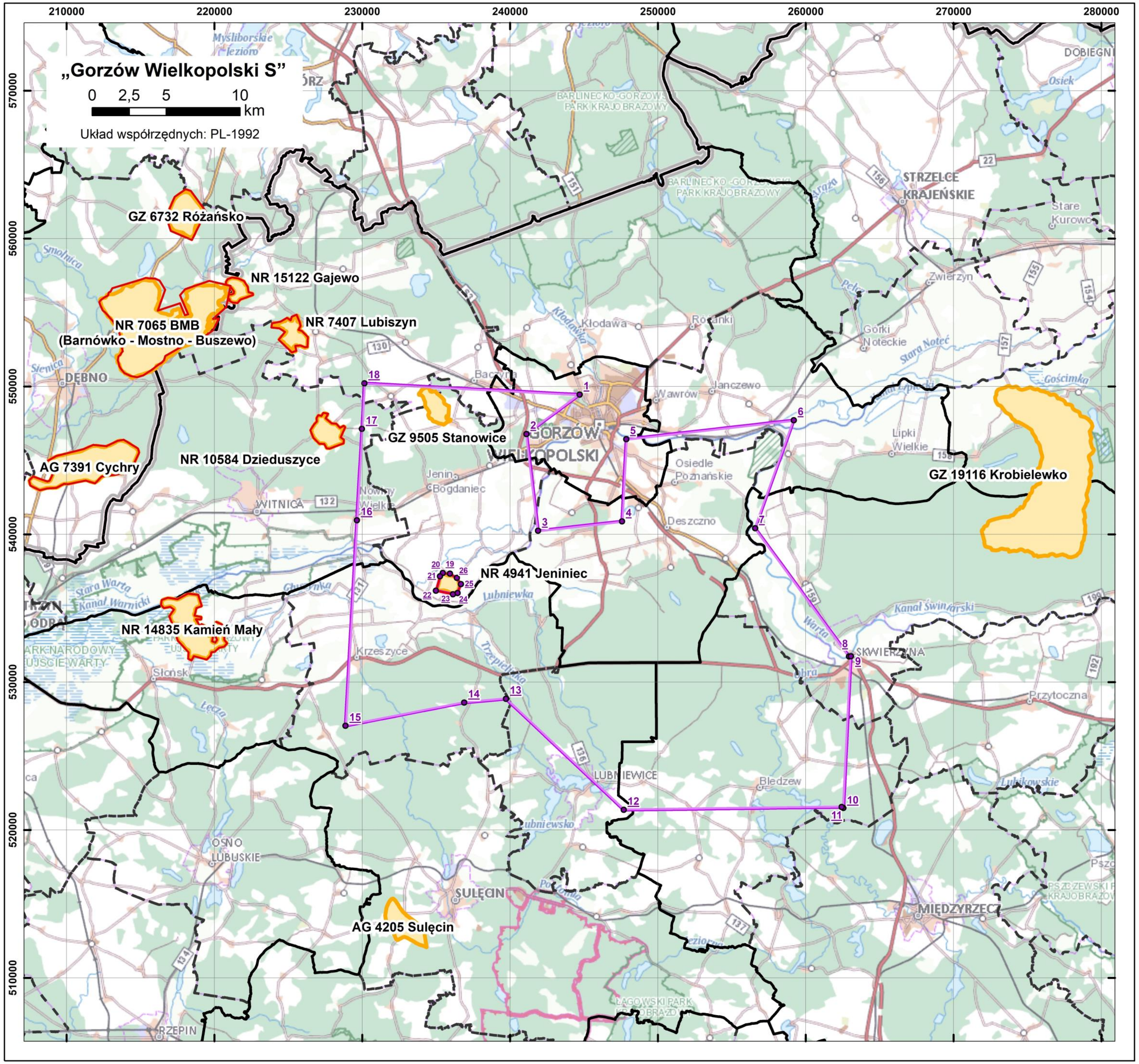
Nr punktu	x	y	Nr punktu	x	y
1	549 450,19	244 711,63	15	527 049,18	228 863,08
2	546 785,65	241 113,57	16	540 948,98	229 635,49
3	540 242,75	241 894,16	17	547 125,25	229 978,70
4	540 873,53	247 572,85	18	550 209,91	230 150,11
5	546 430,59	247 861,28	z wyłączeniem poligonu zdefiniowanego punktami 19-26:		
6	547 712,18	259 199,82			
7	540 414,53	256 580,45	19	537 338,87	235 938,86
8	531 745,15	262 931,15	20	537 381,70	235 451,89
9	531 753,26	263 057,74	21	537 161,68	235 262,61
10	521 496,05	262 559,19	22	536 191,17	234 978,91
11	521 556,67	262 436,44	23	535 945,30	236 140,79
12	521 365,66	247 695,31	24	536 032,11	236 456,84
13	528 872,38	239 725,61	25	536 631,59	236 671,44
14	528 621,24	236 900,92	26	537 053,67	236 400,94



Udokumentowane złoże kopalin, obszary i tereny górnicze: PIG-PIB
System Gospodarki i Ochrony Bogactw Mineralnych Polski MIDAS
Podkład topograficzny: GUGiK
Baza Danych Obiektów Ogólnogeograficznych (BDOO)

Documented field, mining areas and mining counties: the System of management and protection of mineral resources in Poland MIDAS (PGI-NRI)
Topographic background: the Head Office of Geodesy and Cartography (GUGiK)
General-geographical Database (BDOO)

PIG-PIB
Warszawa 2021



4.1. JENINIEC OIL FIELD

Acreage: 142.12 ha
Depth: -2971.0 m a.s.l.
Stratigraphy: Permian – Zechstein/Main Dolomite
Resources:

- Primary exploitable anticipated economic resources (as of 2001):
  108.00 ktonnes of crude oil in cat. A
  12.50 million m^3 of natural gas in cat. A
- Exploitable anticipated economic resources in 2019:
  3.83 ktonnes of crude oil in cat. A
  0.62 million m^3 of natural gas in cat. A
- Economic resources in place in 2019:
  3.83 ktonnes of the crude oil economic resources in place in cat. A, and 225.50 ktonnes of the crude oil sub-economic resources in cat. A
  lack of the natural gas economic resources in place, 26.12 million m^3 of the natural gas sub-economic resources in cat. A
- Production in 2019:
  1.84 ktonnes of crude oil in cat. A
  0.16 million m^3 of natural gas in cat. A.

Reports:

1. Czekański, E., Liberska, H., Michalus, L. 1989. Jeniniec crude oil field report. Inv. 16487 CUG, Arch. CAG PIG, Warsaw. [in Polish]
2. Burdzy, M., Kuś, A. 2001. Jeniniec crude oil field report – supplement 1. Inv. 323/2002, Arch. CAG PIG, Warsaw. [in Polish]
3. Burdzy, M., Kuś, A. 2002. Jeniniec crude oil field report – supplement 2. Inv. 324/2002, Arch. CAG PIG, Warsaw. [in Polish]

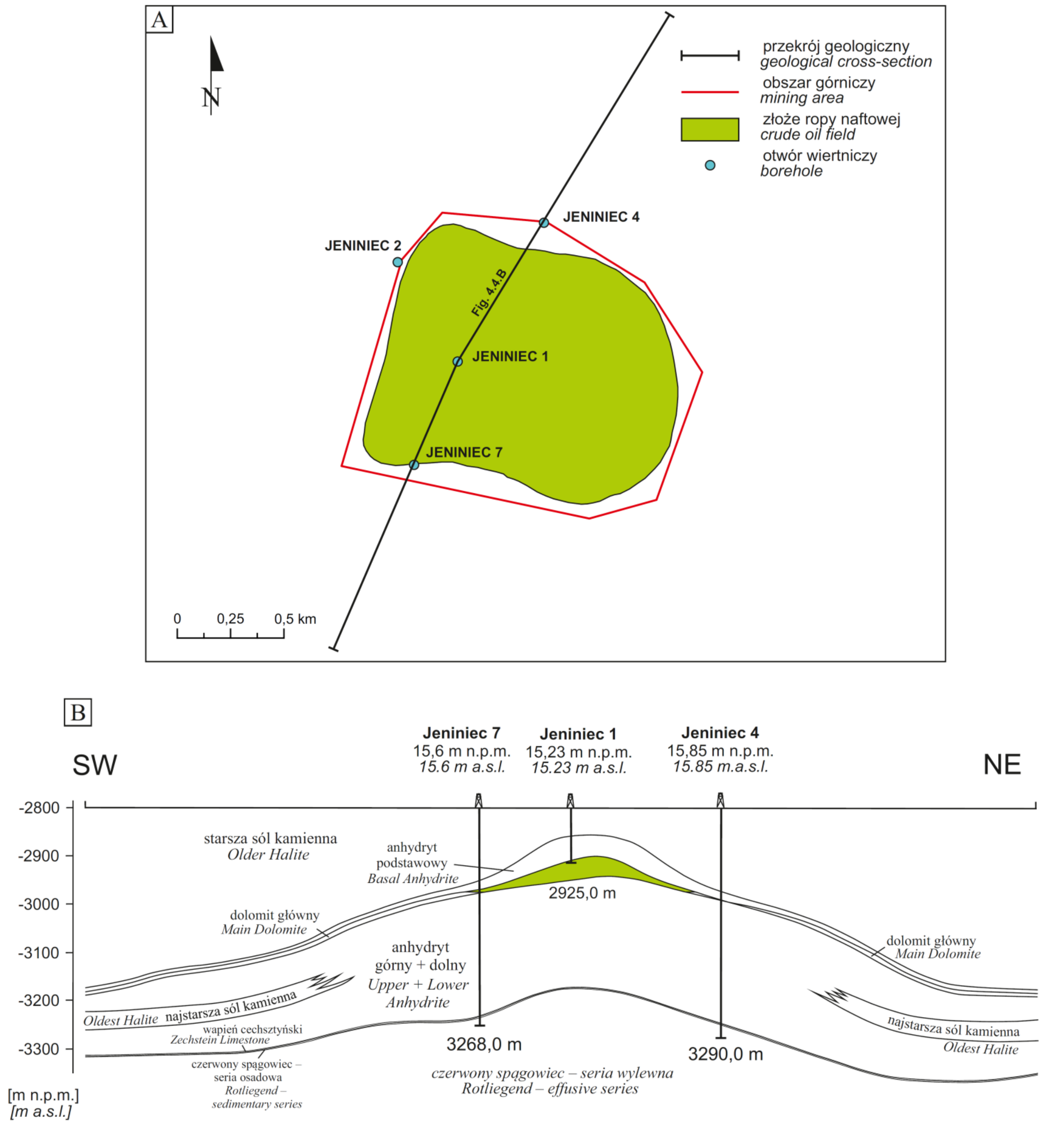


Fig. 4.2. A. Wells and boundaries of the Jeniniec crude oil field (CGDB, 2021). **B.** Geological cross-section through the Jeniniec crude oil field (based on Czekański et al., 1989).

Parameter	Minimum value	Maximum value	Average value	Unit	Comments
current pressure	---------	---------	23.280	MPa	the measurement of 20.11.2000
saturation pressure	---------	---------	21.530	MPa	
primary reservoir pressure	---------	---------	55.010	MPa	
effective reservoir thickness	---------	---------	16.500	m	
saturation by crude oil	---------	---------	70.000	%	
porosity	---------	---------	13.000	%	
permeability	---------	---------	15.030	mD	
reservoir temperature	---------	---------	106.000	°C	
production conditions	---------	---------	---------	–	waterdrive mechanism (dominant)

production factor	---------	---------	0.280	–	
boreholes efficiency	---------	---------	32.000	t/d	the September 2001 average
sand encroachment	---------	---------	---------	%	not defined
quality parameters of crude oil (main raw material)					
Parameter	**Minimum value**	**Maximum value**	**Average value**	**Unit**	**Comments**
crude oil specific weight	---------	---------	0.824	g/cm^3	
naphtha content	---------	---------	20.000	% v/v	
petroleum fraction content	---------	---------	22.200	% v/v	
sulfur content	---------	---------	0.750	% m/m	
quality parameters of natural gas (accompanying raw material)					
Parameter	**Minimum value**	**Maximum value**	**Average value**	**Unit**	**Comments**
combustion heat	11.373	14.693	---------	kcal/m^3	
calorific value	10.359	13.387	---------	kcal/m^3	
C_2H_6 content	9.418	30.664	---------	% v/v	
CH_4 content	22.338	52.730	---------	% v/v	
carbon dioxide content	0.051	0.851	---------	% v/v	
H_2 content	0.008	10.358	---------	% v/v	
He content	0.022	0.049	---------	% v/v	
N_2 content	3.245	34.888	---------	% v/v	
hydrogen sulfide content	2.717	6.573	---------	% v/v	
hydrocarbons content	64.786	93.821	---------	% v/v	
heavy hydrocarbons C_{3+} content	15.698	22.540	---------	% v/v	
heavy hydrocarbons C_{3+} content	406.993	501.900	---------	g/Nm^3	

Tab. 4.1. Parameters of the Jeniniec crude oil field and quality parameters of the raw materials (MIDAS, 2021 according to Czekański et al., 1989; Burdzy and Kuś, 2002).

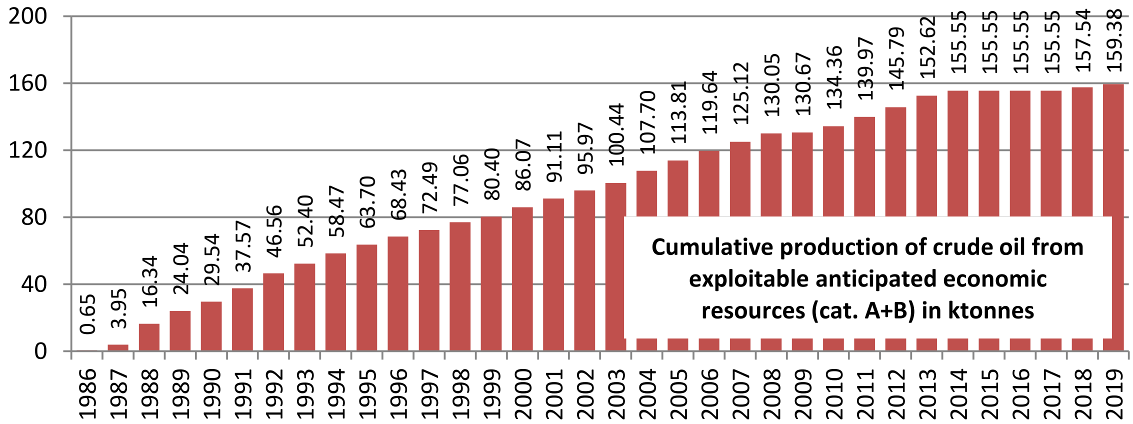


Fig. 4.3. Graph of the crude oil (main raw material) production from the Jeniniec field (based on annual forms of the changes in field resources, sent to PGI-NRI by the concession holder; 1992-2019 period according to MIDAS, 2021; 1989–1991 period according to "The balance of mineral resources deposits in Poland" issued annually; previous years according to the new geological documentation of the field with recalculated resources (Supplement 1) – Burdzy and Kuś, 2001; lack of data from 1986–1988 period in the paper versions of "The balance of mineral resources deposits in Poland").

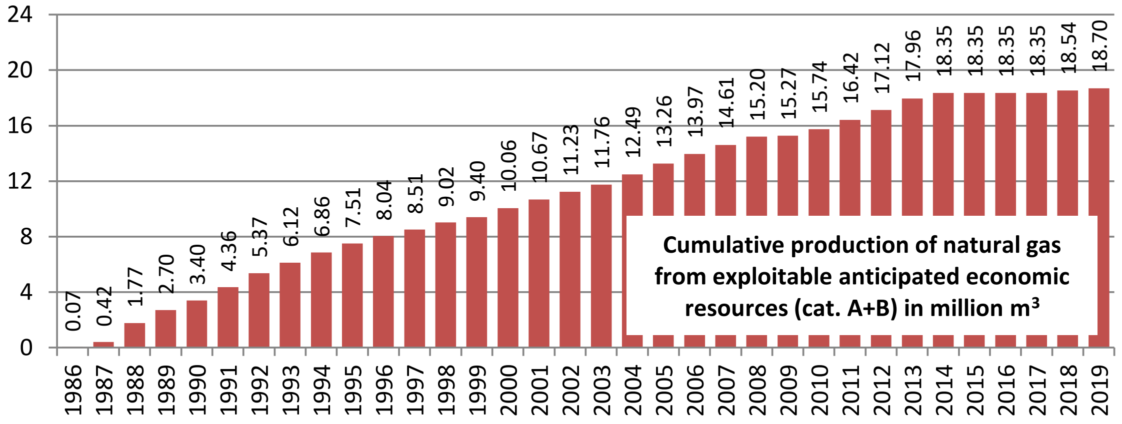


Fig. 4.4. Graph of the natural gas (accompanying raw material) production from the Jeniniec field (based on annual forms of the changes in field resources, sent to PGI-NRI by the concession holder; 1992–2019 period according to MIDAS, 2021; 1989–1991 period according to "The balance of mineral resources deposits in Poland" issued annually; previous years according to the new geological documentation of the field with recalculated resources (Supplement 1) – Burdzy and Kuś, 2001; lack of data from 1986–1988 period in the paper versions of "The balance of mineral resources deposits in Poland").

4.2. STANOWICE NATURAL GAS FIELD

Acreage: 282 ha
Depth: from 3,010.00 to 3,041.00 m b.s.l.
Stratigraphy: Permian – Zechstein/Main Dolomite
Resources:

- Primary exploitable anticipated economic resources (as of 2002):
  603.00 million m^3 of natural gas in cat. C
- Exploitable anticipated economic resources in 2019:
  602.03 million m^3 of natural gas in cat. C
- Economic resources in place in 2019:
  lack of resources
- Production in 2019:
  lack of production

Reports:

1. Zielińska-Pikulska, J. 2003b. Stanowice gas field report Inv. 151/2004, Arch. CAG PIG, Warsaw. [in Polish]

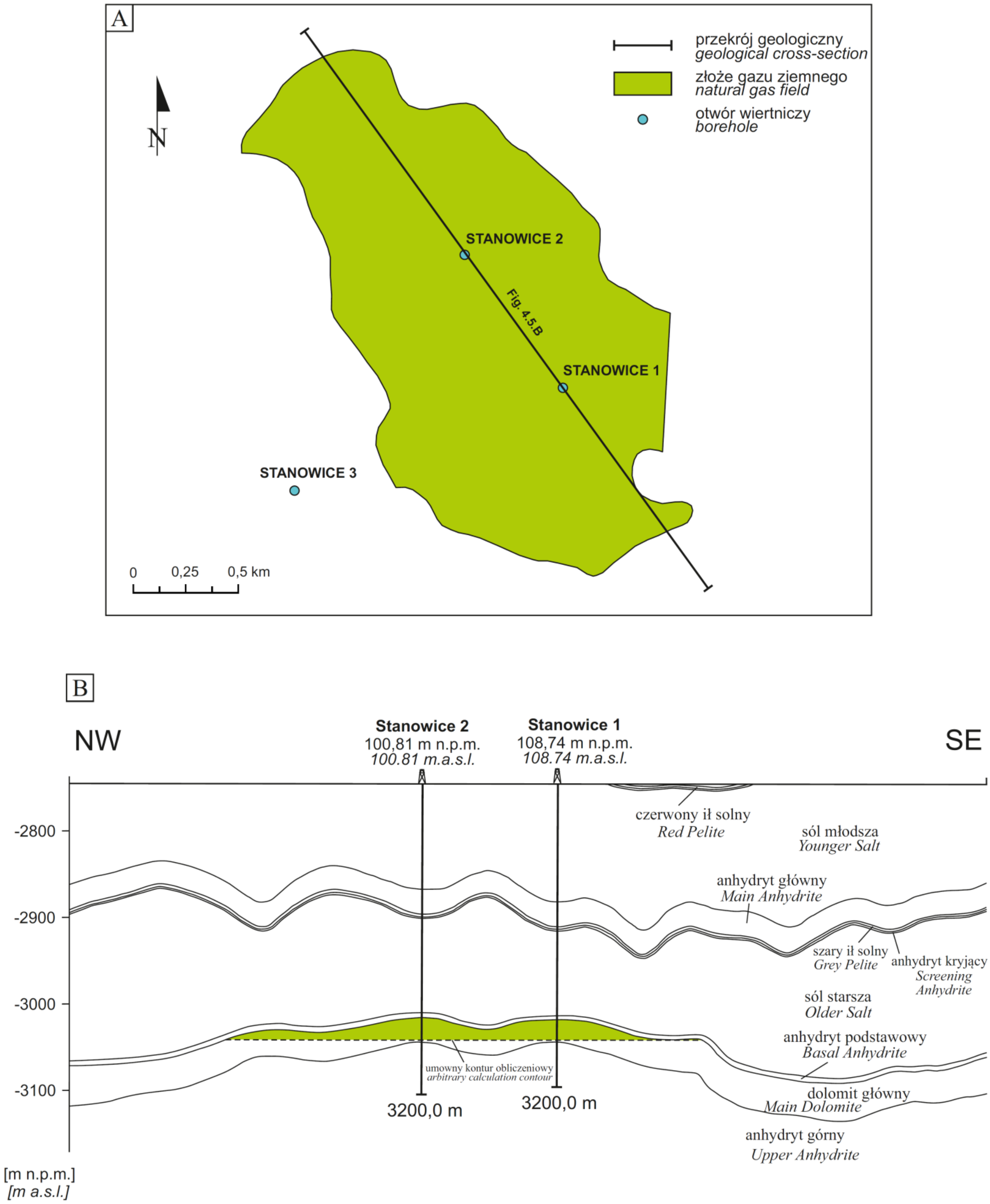


Fig. 4.5. A. Wells and boundaries of the Stanowice natural gas field (CGDB, 2021). **B.** Geological cross-section through the Stanowice natural gas field (based on Zielińska-Pikulska, 2003b).

Parameter	Minimum value	Maximum value	Average value	Unit	Comments
current pressure	---------	---------	55.000	MPa	
bottom pressure P_{ds}	---------	---------	55.050	MPa	Stanowice 2 borehole (23.07-03.08.1998)
bottom pressure P_{ds}	---------	---------	54.960	MPa	Stanowice 1 borehole (13-25.08.1998)
primary reservoir pressure	---------	---------	55.000	MPa	

depth of underlying water	---------	---------	3,041.00	m b.s.l.	not defined, accepted arbitrary calculation contour at the depth of 3,041 m b.s.l.
effective reservoir thickness	---------	---------	16.070	m	
porosity	0.080	34.320	8.280	%	
permeability	0.680	17.000	0.800	mD	
mineralization degree of formation water	---------	---------	325.440	g/l	
reservoir temperature	---------	---------	117.000	°C	
chemical type of formation water	---------	---------	---------	–	Cl-Na-Mg brine
production conditions	---------	---------	---------	–	self-acting production
hydrocarbons saturation factor	---------	---------	0.800	–	
production factor	---------	---------	0.700	–	
absolute efficiency V_{abs}	---------	---------	298.000	Nm^3/min	Stanowice 1 borehole
absolute efficiency V_{abs}	---------	---------	422.000	Nm^3/min	Stanowice 2 borehole
permitted efficiency V_{dozw}	---------	---------	90.000	Nm3/min	Stanowice 2 borehole
permitted efficiency V_{dozw}	---------	---------	50.000	Nm^3/min	Stanowice 1 borehole
crude oil/condensate exponent	---------	---------	0.283	l/Nm^3	0.000210 t/Nm^3
sand encroachment	---------	---------	---------	%	not applicable
quality parameters of natural gas (main raw material)					
Parameter	**Minimum value**	**Maximum value**	**Average value**	**Unit**	**Comments**
density	---------	---------	0.927	-	relative to air
calorific value	---------	---------	16.360	MJ/Nm^3	
C_2H_6 content	---------	---------	3.371	% v/v	
CH_4 content	---------	---------	23.137	% v/v	
carbon dioxide content	---------	---------	0.410	% v/v	
H_2 content	---------	---------	0.027	% v/v	
He content	---------	---------	0.004	% v/v	
Hg content	---------	---------	0.010	mg/m^3	
N_2 content	---------	---------	67.014	% v/v	
hydrogen sulfide content	---------	---------	1.244	% v/v	
heavy hydrocarbons C_{3+} content	---------	---------	243.660	g/Nm^3	

Tab. 4.2. Parameters of the Stanowice natural gas field and quality parameters of the raw material (MIDAS, 2021 according to Zielińska-Pikulska, 2003b).

4.3. DZIEDUSZYCE CRUDE OIL FIELD

Acreage: 316 ha
Depth: -2,974.50 m a.s.l.
Stratigraphy: Permian – Zechstein/Main Dolomite
Resources:

- Primary exploitable anticipated economic resources (as of 2005):
  535.00 ktonnes of crude oil in cat. C
  76.00 million m^3 of natural gas in cat. C
- Exploitable anticipated economic resources in 2019:
  445.45 ktonnes of crude oil in cat. C
  63.71 million m^3 of natural gas in cat. C
- Economic resources in place in 2019:
  226.93 ktonnes of the crude oil economic resources in place in cat. C and 3,253.51 ktonnes of the crude oil sub-economic resources in cat. C
  lack of the natural gas economic resources in place, 494.73 million m^3 of the natural gas sub-economic resources in cat. C
- Production in 2019:
  15.64 ktonnes of crude oil in cat. C
  2.26 million m^3 of natural gas in cat. C

Reports:

1. Strzelecka, D. 2006. Dzieduszyce crude oil field report. Inv. 704/2006, Arch. CAG PIG, Warsaw. [in Polish]

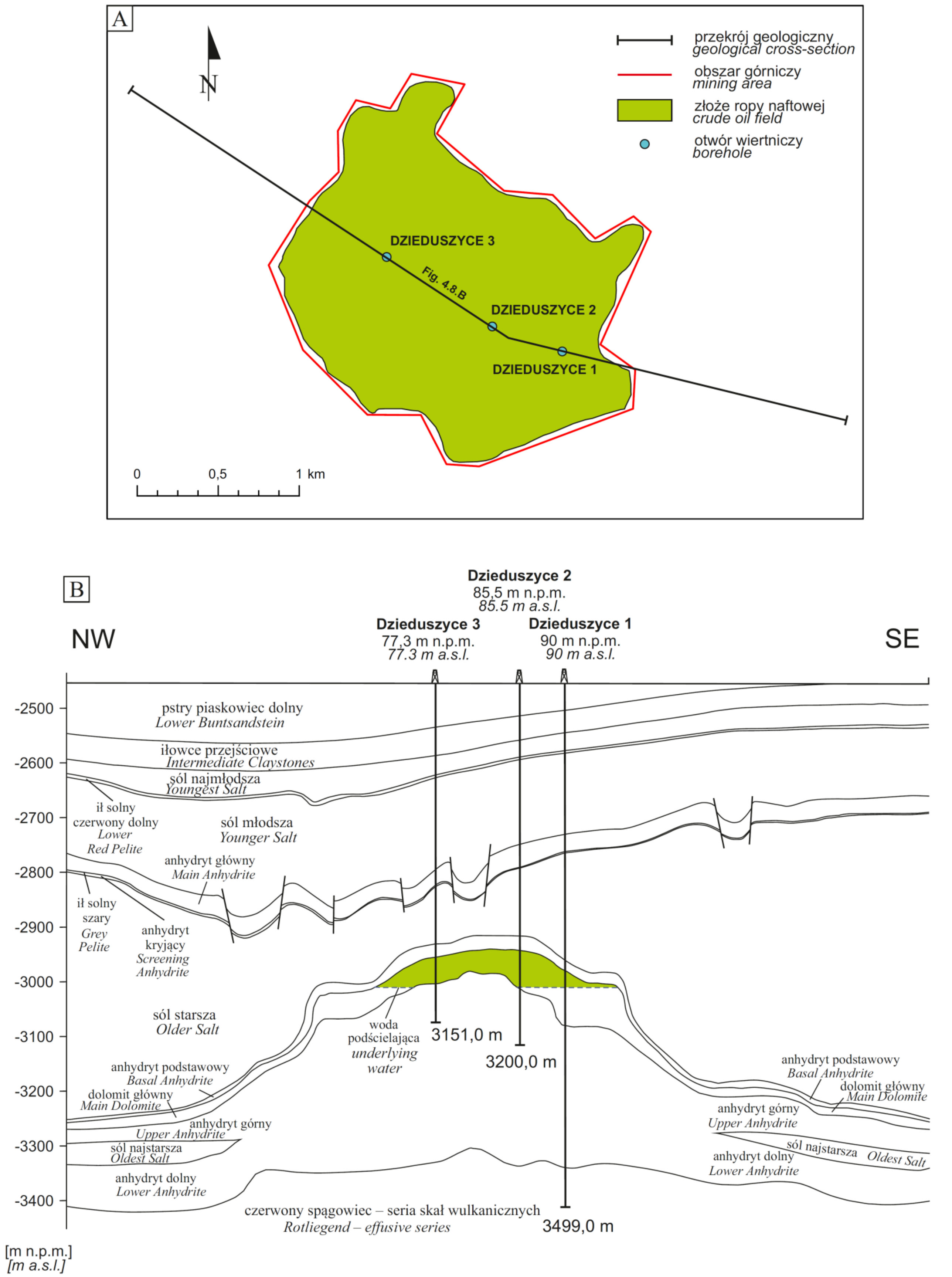


Fig. 4.6. A. Wells and boundaries of the Dzieduszyce crude oil field (CGDB, 2021). **B.** Geological cross-section through the Dzieduszyce crude oil field (based on Strzelecka, 2006).

Parameter	Minimum value	Maximum value	Average value	Unit	Comments
current pressure	---------	---------	51.490	MPa	as of 31.12.2005
primary reservoir pressure	---------	---------	54.760	MPa	at the depth of -2,990 m
depth of underlying water	---------	---------	-3,009.00	m	
effective reservoir thickness	---------	---------	20.500	m	average from the map of the effective thickness
effective porosity	---------	---------	11.370	%	average from the map of the effective porosities
permeability	---------	---------	9.425	mD	
mineralization degree of formation water	---------	---------	281.680	g/l	
reservoir temperature	---------	---------	120.500	°C	at the depth of -2,999 m
chemical type of formation water	---------	---------	---------	–	Cl-Na brine
production conditions	---------	---------	---------	–	expansion of the gas dissolved in crude oil
hydrocarbons saturation factor	---------	---------	0.740	–	
production factor	---------	---------	0.150	–	
absolute efficiency V_{abs}	---------	---------	---------	t/d	not applicable
permitted efficiency V_{dozw}	---------	60.000	---------	t/d	Dzieduszyce 2 borehole
permitted efficiency V_{dozw}	---------	26.000	---------	t/d	Dzieduszyce 3 borehole
gas exponent	---------	---------	142.000	m^3/t	
gas exponent	---------	---------	117.000	m^3/m^3	
water exponent	---------	---------	---------	m^3/t	not measured
sand encroachment	---------	---------	---------	%	not measured
quality parameters of crude oil (main raw material)					
Parameter	**Minimum value**	**Maximum value**	**Average value**	**Unit**	**Comments**
density	0.820	0.828	0.824	g/cm^3	at a temperature of 20°C
viscosity	8.700	24.750	14.780	cSt	
chlorides content	0.000	550.000	65.000	mg/dm^3	
naphtha content	23.000	23.600	23.300	% v/v	
petroleum fraction content	2.400	20.000	11.200	% v/v	
paraffin content	10.030	13.930	11.440	% m/m	
sulfur content	0.230	0.290	0.260	% m/m	
hydrogen sulfide content	20.800	448.800	243.600	mg/dm^3	
quality parameters of natural gas (accompanying raw material)					
Parameter	**Minimum value**	**Maximum value**	**Average value**	**Unit**	**Comments**
combustion heat	31.730	47.580	38.816	MJ/m^3	
density	0.781	0.978	0.812	–	relative to air
Wobbe index	34.780	50.760	40.936	MJ/m^3	
C_2H_6 content	6.840	13.901	10.594	% v/v	
CH_4 content	41.359	49.777	46.284	% v/v	
carbon dioxide content	0.391	9.403	1.675	% v/v	
He content	0.000	0.070	0.022	% v/v	
Hg content	1.948	6.400	3.519	$\mu g/m^3$	
N_2 content	19.932	35.702	27.959	% v/v	
hydrogen sulfide content	1.670	6.301	2.613	% v/v	
hydrocarbons content	41.359	49.777	46.284	% v/v	
heavy hydrocarbons content	6.115	18.604	10.838	% v/v	

Tab. 4.3. Parameters of the Dzieduszyce crude oil field and quality parameters of the raw materials (the MIDAS Database, 2021 according to Strzelecka, 2006).

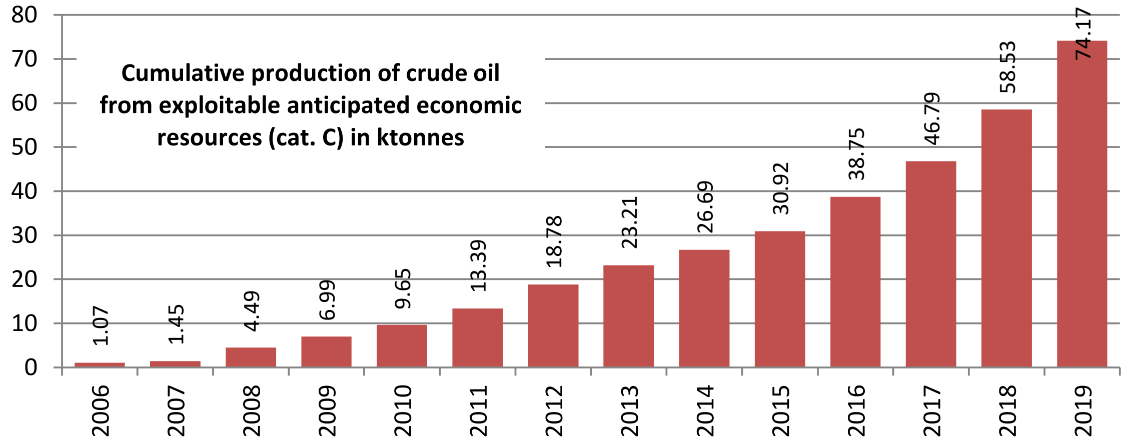


Fig. 4.7. Graph of the crude oil (main raw material) production from the Dzieduszyce field (based on annual forms of the changes in field resources, sent to PGI-NRI by the concession holders according to MIDAS, 2021).

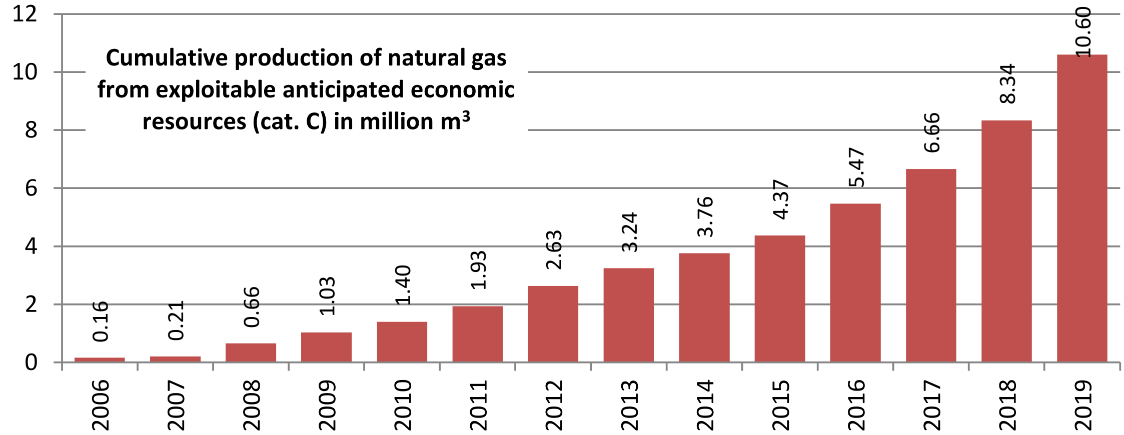


Fig. 4.8. Graph of the natural gas (accompanying raw material) production from the Dzieduszyce field (based on annual forms of the changes in field resources, sent to PGI-NRI by the concession holders according to MIDAS, 2021).

4.4. KROBIELEWKO NATURAL GAS FIELD

The total field acreage: 5,069.50 ha
Depth of occurrence: from -2,936.00 m to -3,240.00 m TVDSS
Stratigraphy: Permian – Zechstein (Stassfurt cyclothem, Main Dolomite)
Resources:

- Primary exploitable anticipated economic resources (as of 2016):
  25,886.50 million m^3 of natural gas in cat. C
  854.00 ktonnes of co-occurring condensate in cat. C
- Exploitable anticipated economic resources in 2019:
  25,886.50 million m^3 of natural gas in cat. C
  854.00 ktonnes of co-occurring condensate in cat. C
- Economic resources in place in 2019:
  15,667.00 million m^3 of the natural gas economic resources in place in cat. C and 36,106.00 million m^3 of the natural gas sub-economic resources in cat. C
  517.00 ktonnes of the co-occurring condensate economic resources in cat. C and 1,191.00 ktonnes of the co-occurring condensate sub-economic resources in cat. C
- Production in 2019:
  lack of production

Reports:

1. Strzelecka, D. 2017. Krobielewko natural gas field report. Inv. 2941/2018, Arch. CAG PIG, Warsaw. [in Polish]

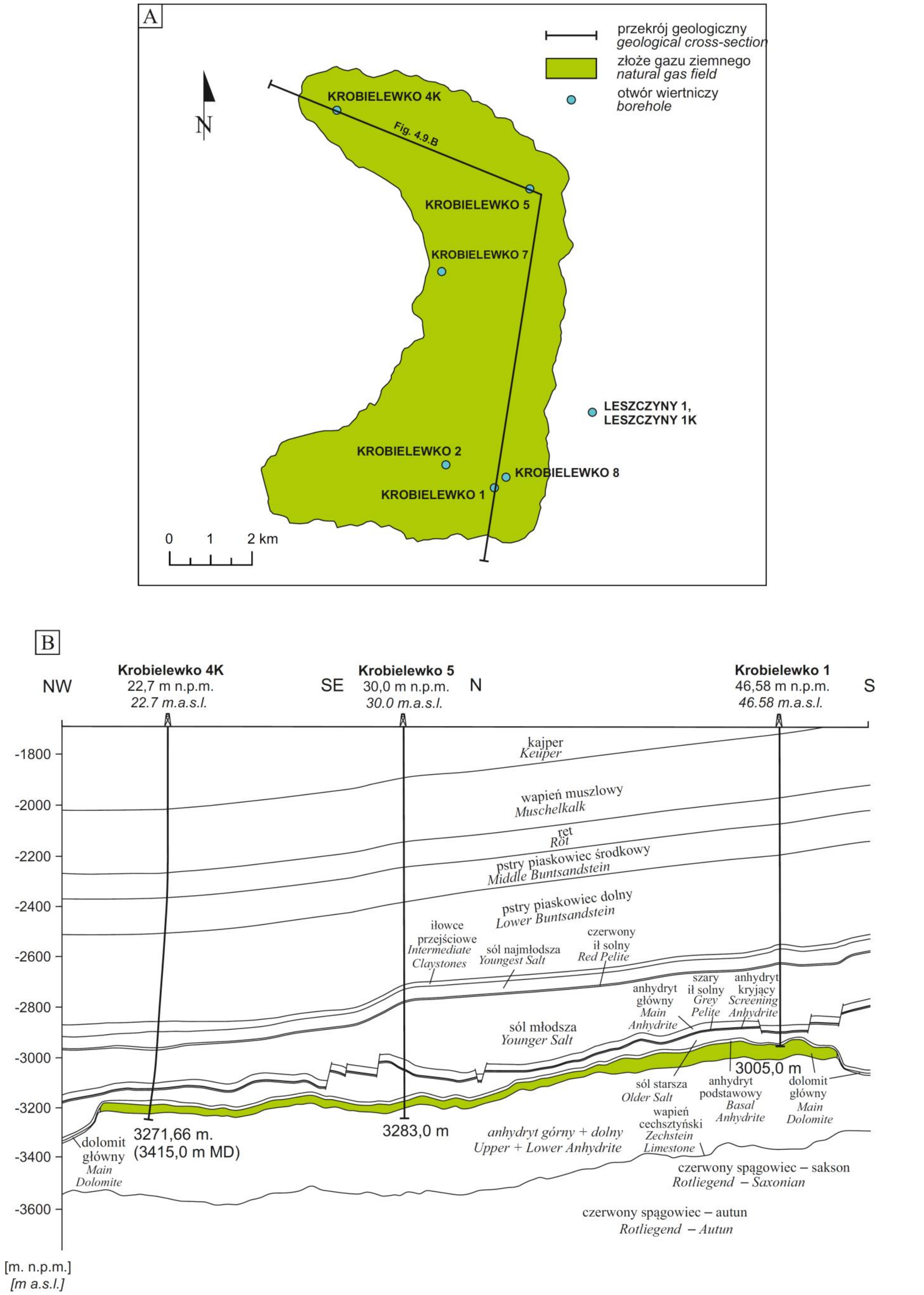


Fig. 4.9. A. Wells and boundaries of the Krobielewko natural gas field and its neighborhood (CGDB, 2021). **B.** Geological cross-section through the Krobielewko natural gas field (based on Strzelecka, 2017).

Parameter	Minimum value	Maximum value	Average value	Unit	Comments
estimation error of average values of the reservoir and resources parameters	---------	---------	41.100	%	for the exploitable resources
estimation error of average values of the reservoir and resources parameters	---------	---------	39.300	%	for the geological resources
current pressure	---------	---------	57.670	MPa	at the depth of -3,088 m TVDSS
primary reservoir pressure	---------	---------	57.670	MPa	at the depth of -3,088 m TVDSS
depth of underlying water	---------	---------	---------	m	not applicable – based on the geophysics drilling interpretation, the reservoir water contour has not been stated
effective reservoir thickness	---------	---------	33.500	m	average from the map of the effective thickness
porosity	---------	---------	11.500	%	
permeability	---------	---------	3.010	mD	
reservoir temperature	---------	---------	118.300	°C	at the depth of -3,088 m TVDSS, 391.28°K
production conditions	---------	---------	---------	–	self-acting production
hydrocarbons saturation factor	---------	---------	85.600	%	
production factor	---------	---------	0.500	–	
absolute efficiency V_{abs}	---------	---------	---------	m^3/min	not applicable
permitted efficiency V_{dozw}	100.000	240.000	184.000	m^3/min	based on production forecast
oil/condensate exponent	---------	---------	33.000	g/m^3	stated based on the average gas composition from Krobielewko 5 borehole using the GasVLevr.3.4 program
water exponent	---------	---------	---------	t/t	not applicable
quality parameters of natural gas (main raw material)					
Parameter	**Minimum value**	**Maximum value**	**Average value**	**Unit**	**Comments**
combustion heat	4.570	17.130	11.268	MJ/m^3	
calorific value	4.150	15.620	10.304	MJ/m^3	
C_2H_6 content	1.054	2.834	1.966	% v/v	
CH_4 content	5.843	20.630	13.736	% v/v	
carbon dioxide content	0.048	1.182	0.490	% v/v	
He content	0.000	0.028	0.013	% v/v	
N_2 content	64.490	91.552	76.887	% v/v	
hydrogen sulfide content	0.457	8.734	4.372	% v/v	
heavy hydrocarbons C_{3+} content	1.190	3.900	2.457	% v/v	
quality parameters of condensate (co-occurring raw material)					
Parameter	**Minimum value**	**Maximum value**	**Average value**	**Unit**	**Comments**
crude oil specific gravity	---------	---------	0.749	g/cm^3	
viscosity	---------	---------	0.900	°E	at a temperature of 20°C
residue after distillation	---------	---------	1.580	% m/m	
naphtha fraction content	---------	---------	96.800	% v/v	

Tab. 4.4. Parameters of the Krobielewko natural gas field and quality of the raw materials (MIDAS, 2021 according to Strzelecka, 2017).

5. WELLS

Sixteen deep wells >500 m MD drilled through or pierced the Main Dolomite within the “Gorzów Wielkpolski S” tender area. These are:

Well name	Year	Owner	Concession (for wells after 1994)	Depth [m]	Stratigraphy at the bottom
Baczyna 1	2000	PGNiG S.A.	Gorzów Wlkp.-Myślibórz 59/95/p	3204.0	Permian
Baczyna-2	2002	State Treasury	Gorzów Wlkp.-Myślibórz 42/2001/p	3167.0	U. Permian
Brzozowa 1	1993	PGNiG S.A.	Lubniewice 57/92/p	3218.0	Permian
Ciecierzyce 1	2001	PGNiG S.A.	Lubniewice 21/95/p	3092.0	U. Permian
Ciecierzyce 1K	2002	State Treasury	Lubniewice 21/95/p	3017.0	U. Permian
Dzierżów 1K	2002	State Treasury	Lubniewice 21/95/p	3130.0	U. Permian
Dzierżów 1K-BIS	2002	State Treasury	Lubniewice 21/95/p	3040.0	U. Permian
Jeniniec 4	1988	State Treasury		3290.0	Permian
Jeżyki 1	1994	PGNiG S.A.	Gorzów-Myślibórz 78/92/p	3401.0	Permian
Lubno 1	1999	PGNiG S.A.	Kostrzyn – Myślibórz 22/95/p	3217.0	U. Permian
Maszków 1	1992	PGNiG S.A.	Lubniewice 57/92/p	3168.0	Permian
Płonica 1	1994	PGNiG S.A.	Lubniewice 57/92/p	3353.0	Permian
Racław 1K	2002	State Treasury	Gorzów Wlkp.-Myślibórz 42/2001/p	3256.0	U. Permian
Stanowice 1	1996	PGNiG S.A.	Gorzów Wlkp.-Myślibórz 59/95/p	3200.0	U. Permian
Stanowice 2	1998	PGNiG S.A.	Gorzów Wlkp.-Myślibórz 59/95/p	3200.0	U. Permian
Stanowice 3	2002	State Treasury	Gorzów Wlkp.-Myślibórz 42/2001/p	3261.0	U. Permian
Wędrzyn 1	2008	State Treasury	Lubniewice 21/95/p	3170.0	Permian
Wędrzyn 5	2009	State Treasury	Lubniewice 21/95/p	3210.0	Permian

General characteristics of the State Treasury’s wells, including hydrocarbon shows and inflows, as well as petrophysical properties of gas-and-oil-bearing intervals, are shortly summarized in Tab. 5.1. One example – Jeniniec 4 well - is illustrated in Fig. 5.2.

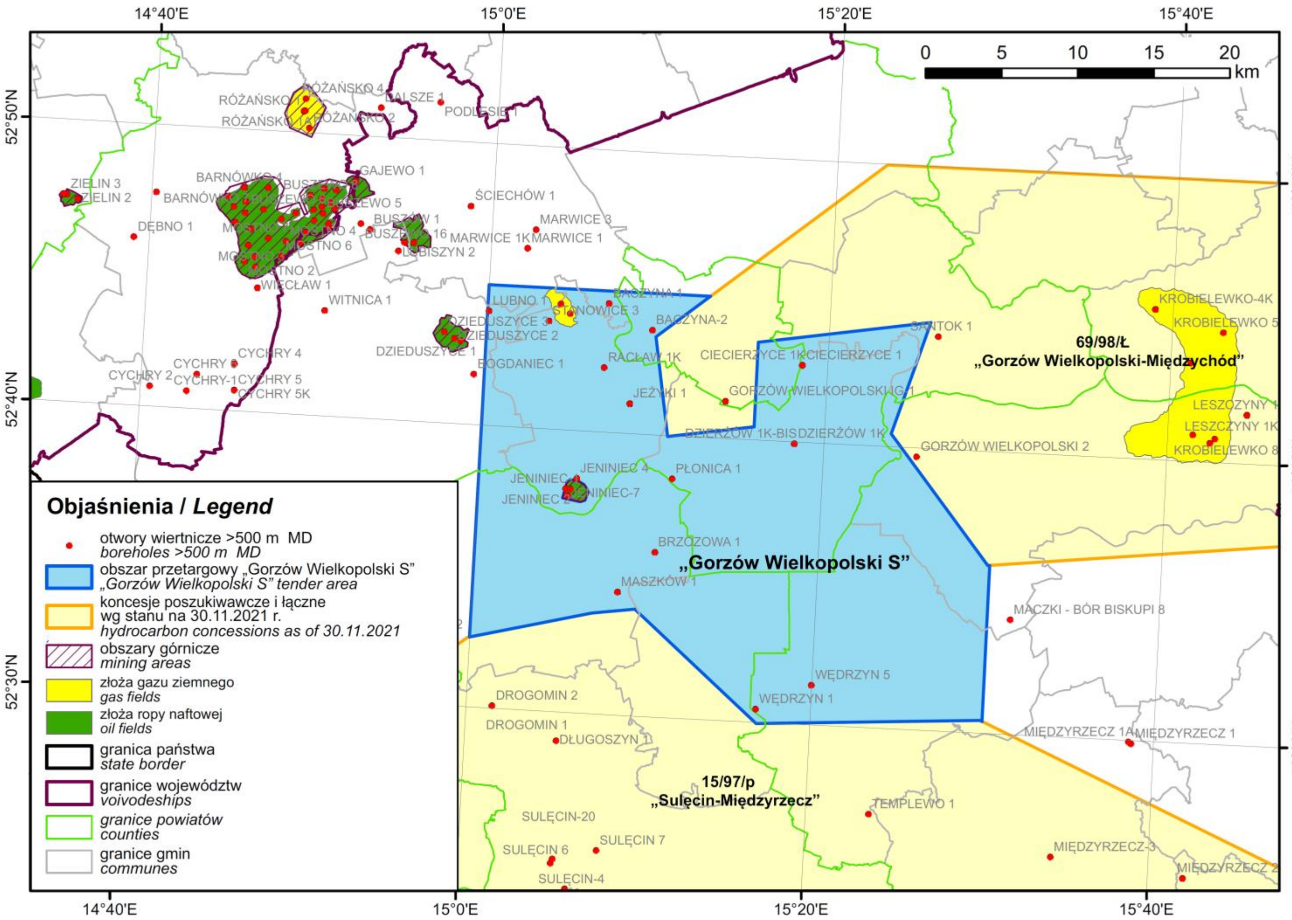


Fig. 5.1. Deep wells (>500 m MD) located within the "Gorzów Wielkpolski S" tender area and in its close neighborhood.

→ **Tab. 5.1.** Summary of stratigraphy, petrophysical properties, hydrocarbon shows (blue squares), hydrocarbon inflows and geophysics in deep wells located within the "Gorzów Wielkpolski S" tender area and in its close neighborhood.

STRATIGRAPHY	BACZYNA 2		2002		CIECIERZYCE 1K		2002		DZIERŻÓW 1K		2002	
	Depth from [m]	Depth to [m]	Porosity [%]/ Permeability [mD]	HC Inflow	Depth from [m]	Depth to [m]	Porosity [%]/ Permeability [mD]	HC Inflow	Depth from [m]	Depth to [m]	Porosity [%]/ Permeability [mD]	HC Inflow
Caenozoic	0	238							0	179.5		
Cretaceous	238	810							179.5	684		
Jurassic	822	1224							684	1091		
Triassic	1224	2689							1091	2552.5		
Permian	2689	3167							2552.5	3130		
Transitional Terrigenous Series PZt												
PZ4	2689	2756							2552.5	2617.5		
Younger Halite Na3	2756	2920			2679	2837			2617.5	2836		
Younger PotashK3												
Lower Younger Halite Na3d												
Main Anhydrite A3	2920	2946			2837	2863			2836	2953		
Grey Pelite T3	2946	2948			2863	2865			2953	2960		
Screening Anhydrite A2r	2948	2950			2865	2866			2960	2961		
Older Halite Na2	2950	3060.5			2866	3003.5			2961	3023		
Older Potash K2												
Lower Older Halite Na2d												
Basal Anhydrite A2	3060.5	3066.5		gas with H_2S and oil; brine with gas and oil	3003.5	3008			3023	3026.5	0.35–20.81/ <0.001–152.615	gas with H_2S
Main Dolomite Ca2	3066.5	3119.5	3.22–37.48/ 0.017–80.201		3008	3017	11–24.98/ 0.023–15.786	gas and condensate	3026.5	3090		
Upper Anhydrite A1g	3119.5	3167							3090	3130		
Upper Oldest Halite Na1g												
Middle Anhydrite A1s												
Lower Oldest Halite Na1d												
Lower Anhydrite A1d												
Zechstein Limestone Ca1												
Rotliegend												
GEOPHYSICS	ILD: 20–3167 m; NPHI: 20–3167 m; PAdt: 30–3158 m; PG: 0–3166.75 m; PG: 0–3167 m; PNG: 260.25–3161 m; POst: 20–3167 m; PSr: 20–3155 m; PSr: 20–3166.75 m; Tx2: 20–3140 m; TW: 20–3140 m; Tr_PW1: 180–3150 m; Tr_PW2: 180–3150 m; Tr_PW3: 180–3150 m; Tr_PO: 180–3150 m; DT_VSP: 20–3140 m.				dRoB: 2686–3008.5 m; NPHI: 2685.5–3004.5 m; PAc: 2645–3006 m; PAdt: 2606.4–3001 m; PAt1: 2606.4–3001 m; PAt2: 2606.4–3001 m; PG: 2606.4–3003.5 m; PK: 2660–3005 m; PSr: 2695.5–3008.5 m; PSrX: 2606.4–2997 m; RHOB: 2686–3008.5 m.				APHI: 2–2578 m; DPHI: 2–2578 m; dRoB: 0–3132 m; ILD: 29–2578 m; ILM: 29–2578 m; ITT: 2–3128 m; MSFL: 2586–3132 m; NPHI: 0–3129 m; PA: 2998–3119 m; PAc: 20–2580 m; PAdt: 2–3128 m; PAt1: 2–3128 m; PAt2: 2–3128 m; PG: 0–3131 m; PGG: 2571–3130 m; CSS: 15–2565 m; PK: 25–2575 m; POst: 29–3129 m; POTA: 2571–3130 m; PSr: 0–3132 m; PSrX: 29–3131 m; RHOB: 0–3132 m; sPGbezU: 2571–3130 m; THOR: 2571–3130 m; URAN: 2571–3130 m.			
DOCUMENTATIONS	Czajka, D. 2019. Baczyna 2 well liquidation report. Inv. 7667/2019, Arch. CAG PIG, Warsaw. [In Polish]				Chruścińska, J., Wiśniewska, S. 2019. Ciecierzyce 1 and Ciecierzyce 1K wells liquidation report. Inv. 8554/2019, Arch. CAG PIG, Warsaw. [In Polish]				Szczawińska, I. 2003. Dzierżów 1K, Dzierżów 1K-BIS wells report. Inv. DW-134921/2, Arch. CAG PIG, Warsaw. [In Polish]			
	Mierzwińska, E., Czaja, E. 2002a. Baczyna 2 well velocity survey report. B17 VS, Arch. CAG PIG, Warsaw. [In Polish]				Solarska, A. 2003. Ciecierzyce 1 and Cie-cierzyce 1K final wells report. Inv. DW-134902/2 Arch. CAG PIG, Warsaw. [In Polish]				Szczawińska, I. 2004. Dzierżów 1K, Dzierżów 1K-BIS wells liquidation report. Inv. 5985/2019, Arch. CAG PIG, Warsaw. [In Polish]			
	Solarska, A. 2002. Baczyna 2 well report. SW/SZ/690, Arch. PGNiG, Warsaw. [In Polish]				Sowa, D., Sikorska-Piekut, W., Puchalski, A., Janowska, J., Strzelecka, D. 2017. Lubniewice 21/95/p final concession report. Inv. 369/2019, Arch. CAG PIG, Warsaw. [In Polish]							

STRATIGRAPHY	DZIERŻÓW 1K-BIS		2002		JENINIEC 4		1988		RACŁAW 1K		2002	
	Depth from [m]	Depth to [m]	Porosity [%]/ Permeability [mD]	HC Inflow	Depth from [m]	Depth to [m]	Porosity [%]/ Permeability [mD]	HC Inflow	Depth from [m]	Depth to [m]	Porosity [%]/ Permeability [mD]	HC Inflow
Caenozoic					0	170			0	195		
Cretaceous					170	621			195	757		
Jurassic					621	960.5			757	1146.5		
Triassic	2365.5	2539			960.5	2372.5			1146.5	2732		
Permian	2539	3040			2372.5	3290			2732	3256		
Transitional Terrigenous Series PZt					2372.5	2397.5						
PZ4	2539	2595.5			2397.5	2451			2732	2807		
Younger Halite Na3	2595.5	2752			2451	2608.5			2807	2977		
Younger PotashK3												
Lower Younger Halite Na3d												
Main Anhydrite A3	2752	2847.5			2608.5	2643			2977	3020		
Grey Pelite T3	2847.5	2850			2643	2645			3020	3022		
Screening Anhydrite A2r	2850	2856			2645	2648.5			3022	3024.5		
Older Halite Na2	2856	2936			2648.5	2987.5						
Older Potash K2									3024.5	3034		
Lower Older Halite Na2d									3034	3102.5		
Basal Anhydrite A2	2936	2952.5	0.67–16.06/ <0.001–13.962		2987.5	3003.5			3102.5	3122		gas with H_2S; gas, oil and brine
Main Dolomite Ca2	2952.5	2997			3003.5	3004	0.37/0.1		3122	3216.5	1.19–34.59/ 0.0–39.68	
Upper Anhydrite A1g	2997	3040							3216.5	3256		
Upper Oldest Halite Na1g												
Middle Anhydrite A1s												
Lower Oldest Halite Na1d												
Lower Anhydrite A1d					3004	3260.5						
Zechstein Limestone Ca1					3260.5	3261.5	~0.29/~0.1					
Rotliegend					3261.5	3290	7.92/0.10–0.11	gas				
GEOPHYSICS	dRoB: 2365.5–3042.5 m; ITT: 2336.5–3034 m; MSFL: 2562–3042 m; NPHI: 2336.5–3036.5 m; PA: 2562–3039 m; PAc: 1955–2562 m; PAdt: 2336.5–3034 m; PAt1: 2336.5–3034 m; PAt2: 2336.5–3034 m; PE: 2562–3042.5 m; PG: 2265–3035 m; CSS: 2325–3030 m; PK: 0–2560 m; PEc: 2562–3042.5 m; POst: 2336.5–3038 m; POTA: 2499.5–3035 m; LLDO: 2762–3012 m; LLSO: 2762–3012 m; PSr: 2265–3042.5 m; RHOB: 2365.5–3042.5 m; THOR: 2499.5–3035 m; URAN: 2499.5–3035 m; Tx2: 20–3020 m; TW: 20–3020 m; Tr_PW1: 45–3021.7 m; Tr_PW2: 45–3021.7 m; Tr_PW3: 45–3021.7 m; Tr_PO: 45–3021.7 m; DT_VSP: 20–3020 m.				logPOst odwr.: 3150–3281 m; logPOst: 3150–3281 m; PA: 2991–3290 m; PAdt: 2990–3291 m; PG: 0–3290 m; PK: 25–3200 m; PNG: 0–3291 m; PNN: 0–3290 m; PO: 2999–1840 m; POg: 30–1841 m; POst odwr.: 3150–3281 m; POst: 1750–3290 m; PSr: 28–3290 m; Tx2: 20–3180 m; TW: 20–3180 m; Tr_PW1: 119–3194 m; Tr_PW2: 119–3194 m; Tr_PW3: 29–3194 m; Tr_PO: 29–3194 m; DT_VSP: 20–3180 m.				DPHI: 254.5–2752 m; dRoB: 254.5–3238 m; ILD: 254.5–2752 m; ILM: 254.5–2752 m; ITT: 254.5–2748 m; MSFL: 2633.5–3256 m; NPHI: 5–3216 m; PA: 2753.5–3256 m; PAc: 29–3236 m; PAdt: 254.5–3246 m; PAt1: 254.5–3246 m; PAt2: 254.5–3246 m; PG: 5–3244 m; PGG: 2710–3235 m; PK: 25–3256 m; POst: 254.5–3252 m; POTA: 2710–3235 m; PSrX: 220–3253 m; PSrY: 220–3253 m; PUW: 3120–3220 m; RHOB: 254.5–3238 m; sPGbezU: 2710–3235 m; THOR: 2710–3235 m; URAN: 2710–3235 m; Tx2: 20–3080 m; TW: 20–3080 m; Tr_PW1: 75–3091.9 m; Tr_PW2: 60–3091.9 m; Tr_PW3: 90–3091.9 m; Tr_PO: 60–3091.9 m; DT_VSP: 20–3080 m.			
DOCUMENTATIONS	Szczawińska, I. 2003. Dzierżów 1K, Dzierżów 1K-BIS wells report. Inv. DW-134921/2, Arch. CAG PIG, Warsaw. [In Polish]				Liberska, H. 1988b. Jeniniec 4 well report. Inv. 130773, Arch. CAG PIG, Warsaw. [In Polish]				Chruścińska, J., Wojtysiak, B. 2019. Racław 1K well liquidation report. Inv. 7698/2019, Arch. CAG PIG, Warsaw. [In Polish]			
	Szczawińska, I. 2004. Dzierżów 1K, Dzierżów 1K-BIS wells liquidation report. Inv. 5985/2019, Arch. CAG PIG, Warsaw. [In Polish]				Klecan, A. 1988. Jeniniec 4 well velocity survey report. J78 VS, Arch. CAG PIG, Warsaw. [In Polish]				Kozikowski, M. 2002. Racław 1K well report. Inv. 134816, Arch. CAG PIG, Warsaw. [In Polish]			
									Wojtysiak, B., Chruścińska, J. 2013. Gorzów Wlkp. – Myślibórz 42/2001/p final concession report. Inv. 5801/2013, Arch. CAG PIG, Warsaw. [In Polish]			

STRATIGRAPHY	STANOWICE 3		2002		WĘDRZYN 1		2008		WĘDRZYN 5		2009	
	Depth from [m]	Depth to [m]	Porosity [%]/ Permeability [mD]	HC Inflow	Depth from [m]	Depth to [m]	Porosity [%]/ Permeability [mD]	HC Inflow	Depth from [m]	Depth to [m]	Porosity [%]/ Permeability [mD]	HC Inflow
Caenozoic	0	268			0	245			0	239		
Cretaceous	268	861			245	577			239	590		
Jurassic	861	1247			577	923			590	954		
Triassic	1247	2726			923	2361			954	2391		
Permian	2726	3261			2361	3170			2391	3210		
Transitional Terrigenous Series PZt	2726	2744.5			2361	2369			2391	2399.5		
PZ4	2744.5	2818.5			2369	2409			2399.5	2442		
Younger Halite Na3	2818.5	3007			2409	2525			2442	2580.5		
Younger PotashK3												
Lower Younger Halite Na3d												
Main Anhydrite A3	3007	3029			2525	2568			2580.5	2607.5		
Grey Pelite T3	3029	3032			2568	2572			2607.5	2611.5		
Screening Anhydrite A2r	3032	3034			2572	2575			2611.5	2613.5		
Older Halite Na2	3034	3065			2575	2894		gas, condensate, brine	2613.5	2903		
Older Potash K2	3065	3113										
Lower Older Halite Na2d												
Basal Anhydrite A2	3113	3133.2		gas, brine with gas	2894	2906	0–3.8/0.0		2903	2912		
Main Dolomite Ca2	3133.2	3227.2	0.7–19.75/ 0.0–15.387		2906	2912			2912	2964	0.01–16.6/ 0.0–19.9	brine with gas
Upper Anhydrite A1g	3227.2	3261			2912	3023			2964	3034		
Upper Oldest Halite Na1g					3023	3062			3034	3082		
Middle Anhydrite A1s					3062	3086			3082	3106		
Lower Oldest Halite Na1d					3086	3090			3106	3111.5		
Lower Anhydrite A1d					3090	3139			3111.5	3154.5		
Zechstein Limestone Ca1					3139	3141		gas	3154.5	3157.5		
Rotliegend					3141	3170			3157.5	3210		brine
GEOPHYSICS	APHI: 32–3261 m; BS: 32–3261 m; DPHI: 4–3261 m; dRoB: 1–3261 m; ILD: 32–2745 m; ILM: 32–2745 m; MSFL: 2766–3260 m; NPHI: 0–3258 m; PA: 3121–3258.5 m; PAc: 10–2765 m; PAdt: 10–3258.5 m; PAt1: 10–3258.5 m; PAt2: 10–3258.5 m; PG: 0–3255.5 m; PGG: 2766–3256.5 m; PK: 25–3260 m; PNG: 3.5–3262 m; POst: 32–3257.5 m; POTA: 2755–3256.5 m; LLDO: 3119.8–3233 m; LLSO: 119.8–3233 m; PSr: 3.5–3261 m; PSrX: 0–3260 m; PSrY: 0–3260 m; PUW: 2810–3230 m; RHOB: 0.75–3261 m; sPGbezU: 2766–3256.5 m; THOR: 2755–3256.5 m; URAN: 2755–3256.5 m; Tx2: 20–3240 m; TW: 20–3240 m; Tr_PW1: 150–3255 m; Tr_PW2: 135–3255 m; Tr_PW3: 180–3255 m; Tr_PO: 135–3255 m; DT_VSP: 20–3240 m.				NPHI: 300–3170 m; PG: 0–3170 m; POst: 300–3170 m; PSr: 30–3170 m; RHOB: 300–3170 m; PW1: 65.5–2285.5 m; PW2: 65.5–3080.5 m; PW3: 65.5–2285.5 m; PW4: 65.5–3080.5 m; DT_VSP: 65.5–3080.5 m.				BS: 35–3210 m; MSFL: 290–3210 m; NPHI: 290–3210 m; PAdt:–290–3210 m; PGG: 0–3210 m; POst: 290–3210 m; PSr: 35–3210 m; RHOB:–290–3210 m; sPGbezU: 0–3210 m; PW:1–9.5–3129.5 m; DT_VSP: 9.5–3129.5 m.			
DOCUMENTATIONS	Mierzwińska, E., Czaja, E. 2002c. Stanowice 3 well velocity survey report. S85 VS, Arch. CAG PIG, Warsaw. [In Polish]				Dalętka, A., Zawadzka-Gruza, M. 2008. Wędrzyn 1 well velocity survey report. W170 VS, Arch. CAG PIG, Warsaw. [In Polish]				Miluk, A. 2009. Wędrzyn 5 well velocity survey report. W171 VS, Arch. CAG PIG, Warsaw. [In Polish]			
	Zielińska-Pikulska, J. 2003a. Stanowice 3 well report. Inv. 134851, Arch. CAG PIG, Warsaw. [In Polish]				Kuczak, M. 2008. Wędrzyn 1 well liquidation report. Inv. 135710, Arch. CAG PIG, Warsaw. [In Polish]				Pyrka, A., Kuczak, M. 2010. Wędrzyn 5 well liquidation report. Inv. 135857, Arch. CAG PIG, Warsaw. [In Polish]			
	Zielińska-Pikulska, J. 2004. Stanowice 3 well liquidation report. Inv. 8449/2019, Arch. CAG PIG, Warsaw. [In Polish]				Sowa, D., Sikorska-Piekut, W., Puchalski, A., Janowska, J., Strzelecka, D. 2017. Lubniewice 21/95/p final concession report. Inv. 369/2019, Arch. CAG PIG, Warsaw. [In Polish]				Sowa, D., Sikorska-Piekut, W., Puchalski, A., Janowska, J., Strzelecka, D. 2017. Lubniewice 21/95/p final concession report. Inv. 369/2019, Arch. CAG PIG, Warsaw. [In Polish]			

APHI: sonic porosity; DPHI: density porosity; ILD: induction deep conductivity; ILM: induction medium conductivity; ITT: interval transit time; MSFL: misco-spherically focused log; PA: full wave sonic; PGG" gamma-gamma denisty log; CSS: chechk shot survey; POTA: potassium; URAN: uranium; THOR: thorium; sPGbezU: uranium free gamma ray; PE: photoelectric log; PEc: photoelectric log check; LLDO: conductivity deep reversed log; LLSO: conductivity medium log; logPOst odwr.: inversed logarithm of the laterolog log; logPOst: logarithm of the laterolog log; PNN: neutron-neutron log; PO: electric log; POg: electric log lateral device; POst odwr.: inversed laterolog log; PUW: dip log; PSrY: Y caliper; PSrX: X caliper; DPHI: density porosity; BS: diameter.

(blue)	hydrocarbon shows

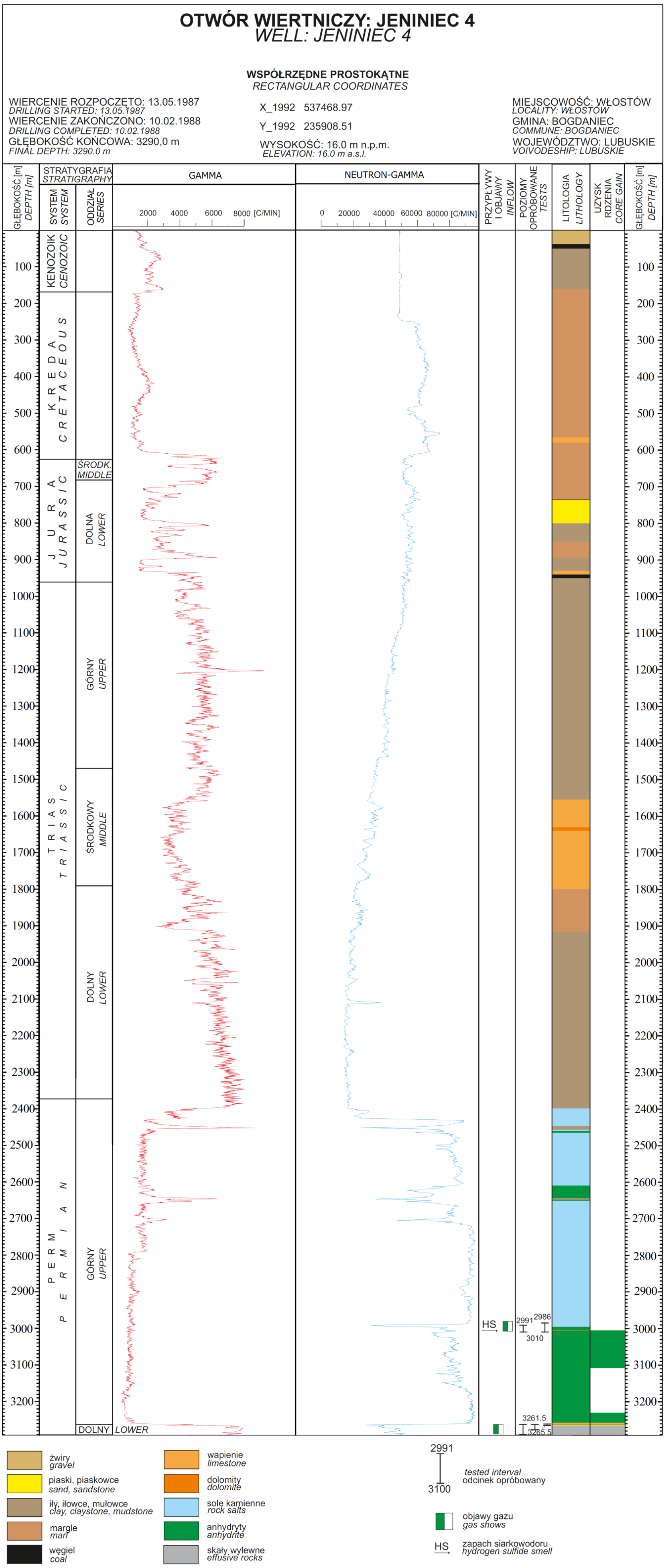


Fig. 5.2. Stratigraphy, lithology, selected well logs and hydrocarbon shows in the Jeniniec 4 well (according to Liberska, 1988b).

6. SEISMIC SURVEYS

The "Gorzów Wielkopolski S" tender area is covered by a dense network of 2D and 3D seismic surveys (Figs 6.1–6.2). First surveys were shot in the late 1950s (when a regional seismic survey was shot in 1959). Further surveys, from 1960s and 1970s, are not used for exploration due to technical capabilities and its quality. Majority of data were acquired in the 1990s. At the moment, these data belong to the investor (Tab. 6.1). The "Gorzów Wielkopolski S" tender area is crossed by a deep seismic sounding P2 section of the POLONAISE'97 experiment. Survey design, resolution, as well as its depth range, make it useless for HC exploration.

The majority of the 3D seismic surveys belong to the investor (Tab. 6.2). They are located in the N part of the tender area. The other data, which belong to the State Treasury, i.e. the recently shot Maszków-Bolemin 3D survey, are situated in the central part, but the information is still restricted to the investor to the end of the currency period.

The list of 2D and 3D seismic surveys is given in Tabs 6.1–6.2 (lines shorter than 2 km are excluded, so are two 3D seismic surveys – Chartów N and Chartów W of 0.8 km^2 and 1.1 km^2, respectively). Seismic surveys conducted within the "Gorzów Wielkopolski S" tender area enable to identify lots of highs and prospective structures. The most important are:

STRUCTURES	SEISMIC HORIZON
Ciecierzyce E High	Z2, Z1', P1
Ciecierzyce W High	Z2, Z1', P1
Dzierżów Structure	Z2,
Płonica Structure	Z2, Z1', P1
Trzebieszewo High	Z2, P1
Trzebieszewo E Structure	Z2, P1
Bolemin Structure	Z2, Z1', P1
Bledzew Structure	Z2, Z1', P1
Bledzew W High	Z1'
Bledzew E High	Z1'
Bledzew S High	Z1', P1
Lubniewice Structure	Z2, Z1', P1
Brzozowa Structure	Z2, Z1', P1
Maszków Structure	Z2, Z1', P1
Dzieduszyce N Structure	Z2, Z1'
Stanowice Structure	Z2, Z1'
Bogdaniec Structure	Z2, Z1'
Bogdaniec E High	Z1'
Jeżyki Structure	Z2, Z1'
Jeniniec Structure	Z2, Z1'

2D line name	Year	Region	Owner	Length [km]
T0220175	1975	Międzyrzecz – Nowy Tomyśl	State Treasury	11.09
T0330175	1975	Międzyrzecz – Nowy Tomyśl	State Treasury	2.12
T0050176	1976	Skwierzyna – Nowa Sól	State Treasury	17.25
T0080176	1976	Skwierzyna – Nowa Sól	State Treasury	3.38
TC150876	1976	Kostrzyń – Skwierzyna	State Treasury	2.68
TD150876	1976	Kostrzyń – Skwierzyna	State Treasury	5.97
T0010477	1977	Sulęcin – Świebodzin	State Treasury	24.16
T0020477	1977	Sulęcin – Świebodzin	State Treasury	4.34
T0030477	1977	Sulęcin – Świebodzin	State Treasury	3.06
T0300477	1977	Sulęcin – Świebodzin	State Treasury	20.73
T0320477	1977	Sulęcin – Świebodzin	State Treasury	15.8
T0340477	1977	Sulęcin – Świebodzin	State Treasury	7.73
T0080378	1978	Kostrzyn – Gorzów Wielkopolski	State Treasury	2.04
T0150378	1978	Kostrzyn – Gorzów Wielkopolski	State Treasury	24.03
T0160378	1978	Kostrzyn – Gorzów Wielkopolski	State Treasury	25.6
T0240378	1978	Kostrzyn – Gorzów Wielkopolski	State Treasury	9.55
T0250378	1978	Kostrzyn – Gorzów Wielkopolski	State Treasury	6.78
T0290378	1978	Kostrzyn – Gorzów Wielkopolski	State Treasury	8.59
T0350378	1978	Myślibórz – Krzyż	State Treasury	2.55
T0390378	1978	Kostrzyn – Gorzów Wielkopolski	State Treasury	2.09
T0460378	1978	Kostrzyn – Gorzów Wielkopolski	State Treasury	17.6
T0470378	1978	Kostrzyn – Gorzów Wielkopolski	State Treasury	19.14
T0500378	1978	Kostrzyn – Gorzów Wielkopolski	State Treasury	9.47
T0510378	1978	Kostrzyn – Gorzów Wielkopolski	State Treasury	13.09
T0150379	1979	Myślibórz – Krzyż	State Treasury	14.78
T0160379	1979	Myślibórz – Krzyż	State Treasury	23.16
T0170379	1979	Myślibórz – Krzyż	State Treasury	7.29
T0180379	1979	Myślibórz – Krzyż	State Treasury	14.6
T0190379	1979	Myślibórz – Krzyż	State Treasury	13.45
T0520379	1979	Myślibórz – Krzyż	State Treasury	12.65
TA350379	1979	Myślibórz – Krzyż	State Treasury	10.15
W17A0184	1984	Chociwel – Czaplinek	State Treasury	6.35
T0250287	1987	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	State Treasury	2.96
T0260287	1987	Kostrzyń	State Treasury	2.2
T0280288	1988	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	State Treasury	12.06
T0400288	1988	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	State Treasury	6.44
T0470288	1988	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	State Treasury	17.71
T0480288	1988	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	State Treasury	4.51
T0410289	1989	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	13.36
T0420289	1989	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	12.79
T0430289	1989	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	13.44
T0440289	1989	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	16.77
T0450289	1989	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	12.95
T0460289	1989	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	12.75
T0770290	1990	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	11.99
T0780290	1990	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	14.47
T0800290	1990	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	11.31
T0810290	1990	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	24.33
T0820290	1990	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	24.89
T0830290	1990	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	8.91
T0840290	1990	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	10.49
T0850290	1990	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	21.63
T0100293	1990	Chojna – Gorzów Wlkp. – Strzelce Krajeńskie	PGNiG S.A.	2.21
T0190293	1993	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	11.98
T0200293	1993	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	20.87
T0210293	1993	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	15.89
T0320293	1993	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	6.1
T0370293	1993	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	12.84
T0390293	1993	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	11.94
T0180294	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	6.66
T0270294	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	15.39

T0310694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	7.75
T0320694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	10.28
T0330694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	12.56
T0340694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	11.65
T0350694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	10.24
T0360694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	11.76
T0370694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	14.46
T0400294	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	13.46
T0420694	1994	Sulęcin – Międzyrzecz	PGNiG S.A.	2.05
T1150694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	10.48
T1160694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	9.94
T1170694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	9.64
T1330694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	11.74
T1340694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	12.1
T1350694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	12.07
T1360694	1994	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	10.26
T0210295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	8.85
T0220295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	8.55
T0230295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	10.93
T0240295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	10.86
T0250295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	10.29
T0260295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	9.73
T0270295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	15
T0280295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	13.41
T0290295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	15.27
T0300295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	16.85
T0310295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	20.51
T0320295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	15.48
T0330295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	17.71
T0340295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	17.85
T0350295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	14.77
T0360295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	16.07
T0370295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	20.56
T0380295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	18.68
T0390295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	24.84
T0400295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	10.05
T0410295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	23.41
T0420295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	25.88
T0430295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	12.48
T0440295	1995	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	10.57
T0440695	1995	Sulęcin – Międzyrzecz	PGNiG S.A.	6
T0550695	1995	Sulęcin – Międzyrzecz	PGNiG S.A.	3.74
T0740695	1995	Sulęcin – Międzyrzecz	PGNiG S.A.	2.41
T0300696	1996	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	8.89
T0310696	1996	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	12.43
T0320696	1996	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	8.22
T0330696	1996	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	17.27
T0340696	1996	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	11.43
T0350696	1996	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	24.9
T0360696	1996	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	25.02
T0450296	1996	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	8.97
T0450696	1996	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	7.43
T0500696	1996	Dzieduszyce – Gorzów Wlkp. – Lubniewice	PGNiG S.A.	8.87
T0510696	1996	Sulęcin – Międzyrzecz	PGNiG S.A.	2.86
T0520696	1996	Sulęcin – Międzyrzecz	PGNiG S.A.	2.76
T0590696	1996	Sulęcin – Międzyrzecz	PGNiG S.A.	7.38
T0010697	1997	Sulęcin – Międzyrzecz	PGNiG S.A.	7.32
T0530697	1997	Sulęcin – Międzyrzecz	PGNiG S.A.	5.34
T0540597	1997	Sulęcin – Międzyrzecz	PGNiG S.A.	2.31
T0560597	1997	Sulęcin – Międzyrzecz	PGNiG S.A.	9.08
T0570597	1997	Sulęcin – Międzyrzecz	PGNiG S.A.	7.57
T0580597	1997	Sulęcin – Międzyrzecz	PGNiG S.A.	5.44
T0710497	1997	Sulęcin – Międzyrzecz	PGNiG S.A.	2.38

T0180498	1998	Gorzów Wielkopolski – Międzychód	PGNiG S.A.	10.45
T0190498	1998	Gorzów Wielkopolski – Międzychód	PGNiG S.A.	7.37
T0200498	1998	Gorzów Wielkopolski – Międzychód	PGNiG S.A.	5.75
T0210498	1998	Gorzów Wielkopolski – Międzychód	PGNiG S.A.	8.78
T0220498	1998	Gorzów Wielkopolski – Międzychód	PGNiG S.A.	7.71
T0230498	1998	Gorzów Wielkopolski – Międzychód	PGNiG S.A.	5.27
T0260498	1998	Gorzów Wielkopolski – Międzychód	PGNiG S.A.	7.18
T0560499	1999	Międzyrzecz – Międzychód	PGNiG S.A.	8.91
T0570499	1999	Międzyrzecz – Międzychód	PGNiG S.A.	3.6
T0590499	1999	Międzyrzecz – Międzychód	PGNiG S.A.	7.52
T0600499	1999	Międzyrzecz – Międzychód	PGNiG S.A.	8.29
T0110500	2000	Międzyrzecz – Międzychód	PGNiG S.A.	8.41
T0180500	2000	Międzyrzecz – Międzychód	PGNiG S.A.	5.33
			Total length:	
			State Treasury	407.15
			Private Inwestor	1145.59

Tab. 6.1. List of 2D seismic surveys within the “Gorzów Wielkopolski S” tender area (lines longer than 2 km).

3D seismic survey name	Year	Concession (for surveys after 2001)	Owner	Acreage [km^2]
Dzieduszyce – Stanowice 3D	1997		PGNiG S.A.	86.92
Gorzów Wielkopolski – Santok 3D	2000		PGNiG S.A.	168.76
Nowa Wieś – Templewo 3D	2001		PGNiG S.A.	4.42
Wędrzyn 3D	2005	Sulęcin-Międzyrzec 15/97/p, Lubniewice 21/95/p	State Treasury	32.99
Sulęcin- 3D	2013	Sulęcin-Międzyrzec 15/97/p, Lubniewice 21/95/p, Chartów-Ośno Lubuskie 26/99/p	State Treasury	4.84
Maszków – Bolemin 3D	2014		State Treasury	119.28
			Total acreage:	
			State Treasury	157,11
			Private Investor	260,1

Tab. 6.2. List of 3D seismic surveys within the “Gorzów Wielkopolski S” tender area (Chartów N and Chartów W surveys excluded).

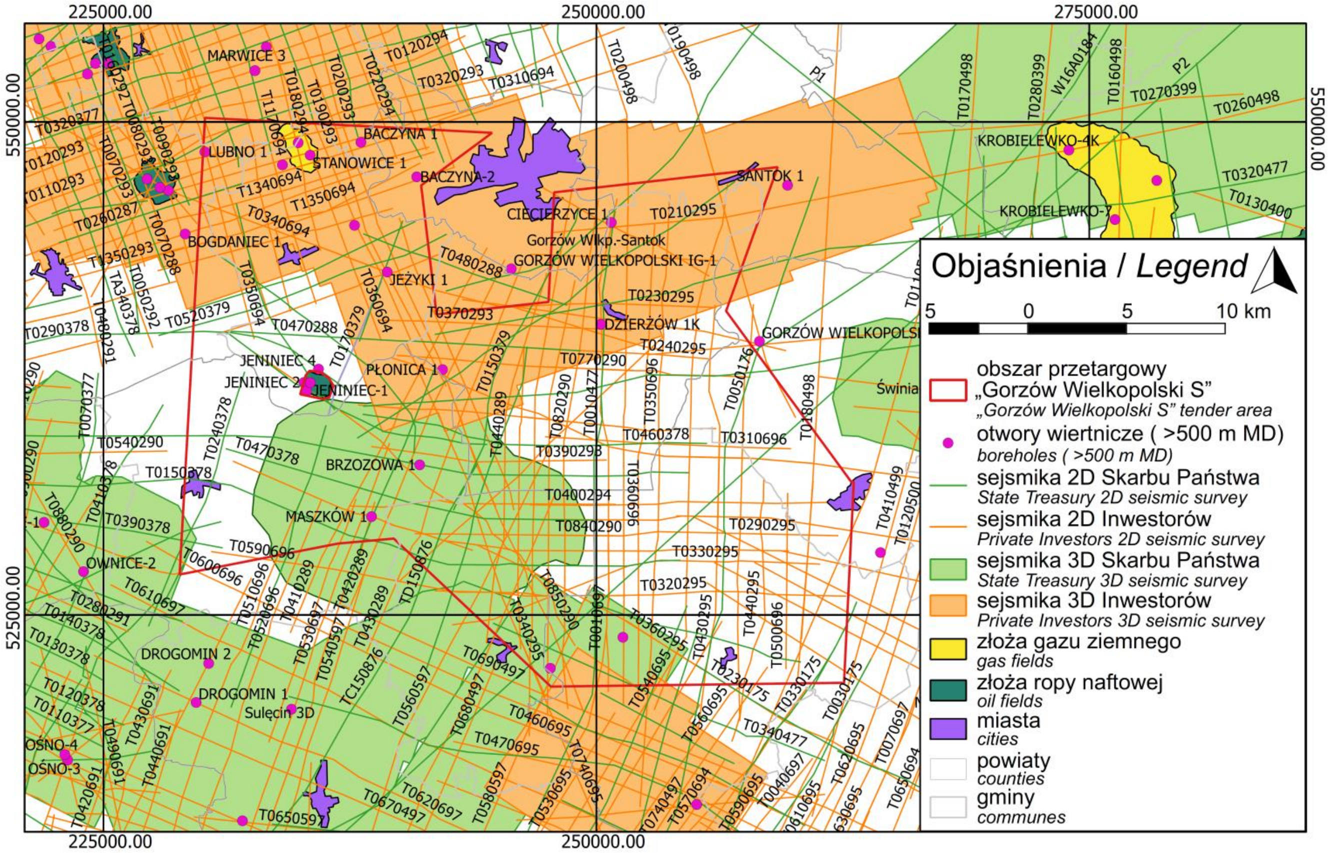


Fig. 6.1. Seismic surveys in the “Gorzów Wielkopolski S” tender area and in its neighborhood with location of deep wells and hydrocarbon fields (CGDB, 2021).

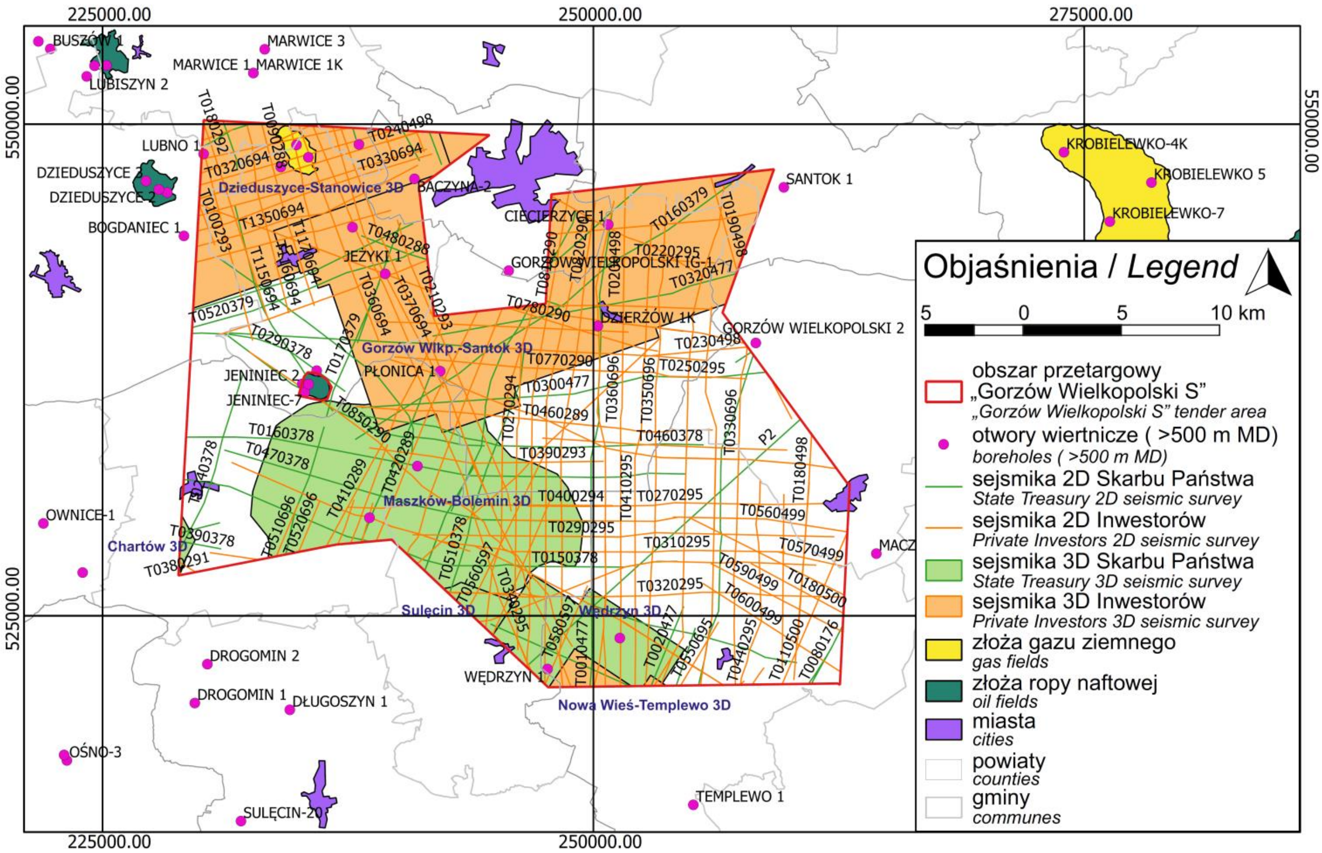


Fig. 6.1. Seismic surveys in the “Gorzów Wielkopolski S” tender area with location of deep wells and hydrocarbon fields (CGDB, 2021).

7. GRAVIMETRY, MAGNETOMETRY AND MAGNETOTELLURICS

7.1. GRAVIMETRY

Semidetailed gravimetric surveys in the “Gorzów Wielkopolski S” tender area and in its close neighborhood were acquired with a point density of ca. 2.5 stations/km^2 (Fig. 7.1). All data are available in the CGSB (2021). There are 1716 data points within the tender area (Fig. 7.1), coming from the “Szczecin Basin and outer zone of Fore-Sudetic Monocline” survey (Kleszcz, 1973) and 11 data points from the “Mogilno Synclinorium” survey (Bochnia and Duda, 1968). The tender area is adjacent in the south to the Gorzów – Jarocin survey (Duda and Kruk, 1973).

There are 280 data points of detailed survey, collected along 2 profiles. One is acquired with a 200 m step (Kleszcz, 1975). The other one focused on brown coal exploration, and is acquired with a 50 m step (Okulus et al., 1981).

The most recent detailed survey, not included in the CGDB yet, covers the whole tender area. The „Chojna – Międzyrzecz” survey (Musiatewicz and Lisowski, 1993) was collected with a point density of ca. 5.5 stations/km^2 and it was focused on a tectonic structure of the Lower Zechstein and Rotliegend sediments.

Królikowski and Petecki (1995) proposed a division of Poland into several gravity regions. Thus, the “Gorzów Wielkopolski S” tender area is placed within the north-west end of the Szczecin–Mogilno–Miechów Low (Fig. 7.2), whose source is defined indefinitely. Most researchers assume the dominant role of the crystalline basement in its formation. The influence of the Variscan orogen is also not excluded.

7.2. MAGNETOMETRY

A ground, semidetailed survey of the total magnetic field intensity was conducted in the “Gorzów Wielkopolski S” tender area (Kosobudzka, 1991). The survey has an average density of 3 stations/km^2. All data are available in the CGDB (2021). There are 2737 data points within the “Gorzów Wielkopolski S” tender area (Fig. 7.3).

An image of magnetic anomalies presented in Fig. 7.4 is taken from the magnetic map of Poland (Petecki and Rosowiecka, 2017). The map is divided into several regions with different magnetic characteristics. The “Gorzów Wielkopolski S” tender area is located within the Central and Western Poland domain (CWPd). This domain is a vast magnetic low in which there are no strong anomalies of regional importance. The absence of magnetic anomalies in this domain suggests either consistently lower magnetization of the basement rocks in comparison to the neighboring magnetic domains, or a smooth top of the basement at a great depth.

7.3. MAGNETOTELLURICS

The earliest magnetotelluric studies at the “Gorzów Wielkopolski S” tender area were the Gorzów Wielkopolski – Chojna survey (Śmiechowski, 1968) and the "Myślibórz – Międzyrzecz" survey (Śmiechowski, 1973). The yellow area marked in Fig. 7.5 is the result of combining both of them. These data are not available digitally from the CGDB (2021). The aim of the works was to detect sub-Permian structures, the zones of Rotliegend occurrence, and to map the Zechstein top.

Magnetotelluric measurements along two regional profiles D-PL and BMT-5 were collected in 2007-2008 (Stefaniuk et al., 2008). MT soundings were separated by approx. 4.6 km from each other along the profiles (Fig. 7.5). Resistivity sections and geological models are the most important result of the survey.

As part of the project "Assessment of potential, heat balance and prospective geological structures for the needs of closed geothermal systems (Hot Dry Rocks) in Poland" (Wójcicki et al., 2013), a set of 320 magnetotelluric soundings along 9 profiles (Stefaniuk et al., 2011) was acquired. Two of them (profiles 3 -HDR-10 and 7-HDR-10) enter the “Gorzów Wielkopolski S” tender area (Fig. 7.5), and the remaining ones are directly adjacent to the area from the north-west. Maps of the distribution of the longitudinal resistance of the Zechstein deposits, the thickness of the sub-Zechstein deposits of low and high resistance were included.

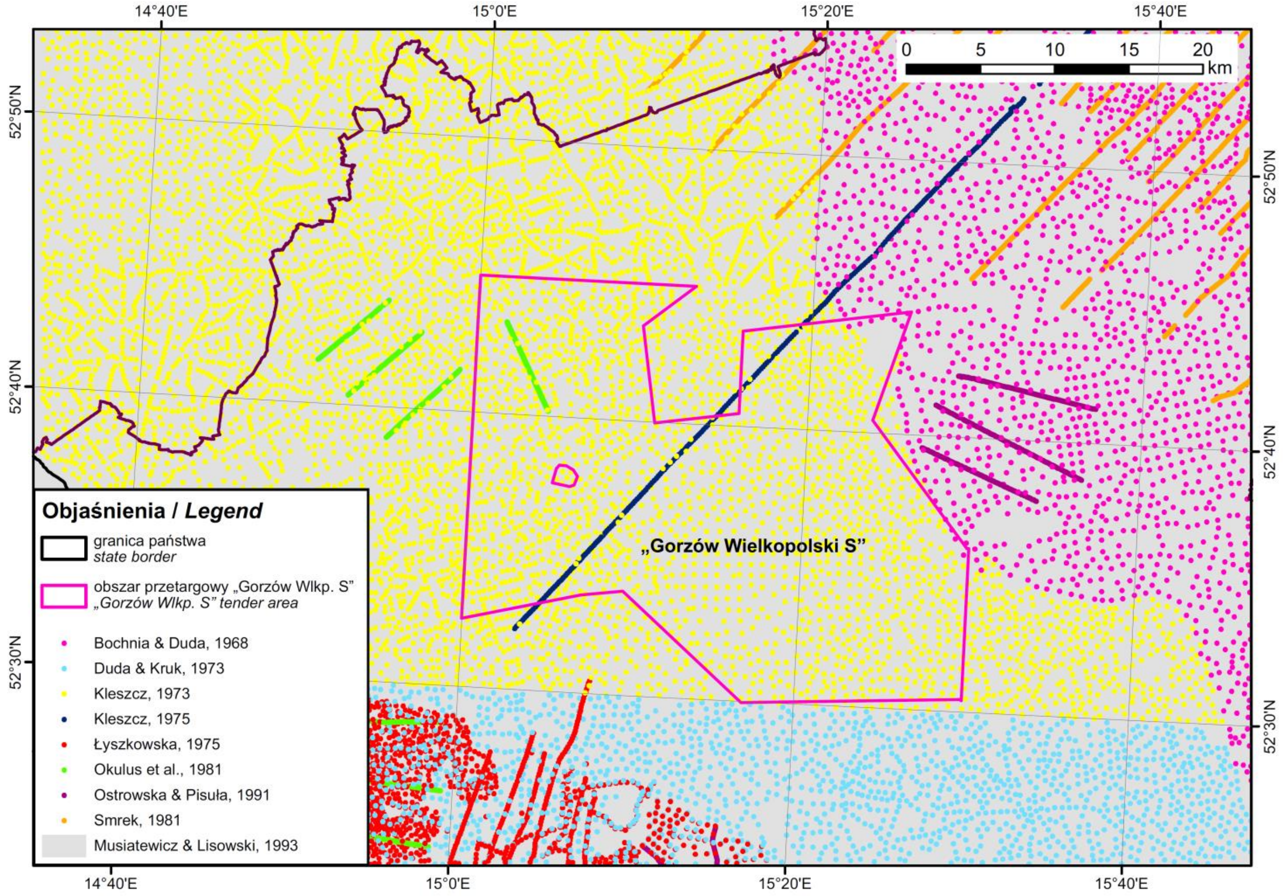


Fig. 7.1. Distribution of gravimetric measurements in the "Gorzów Wielkopolski S" tender area (based on CGDB, 2021).

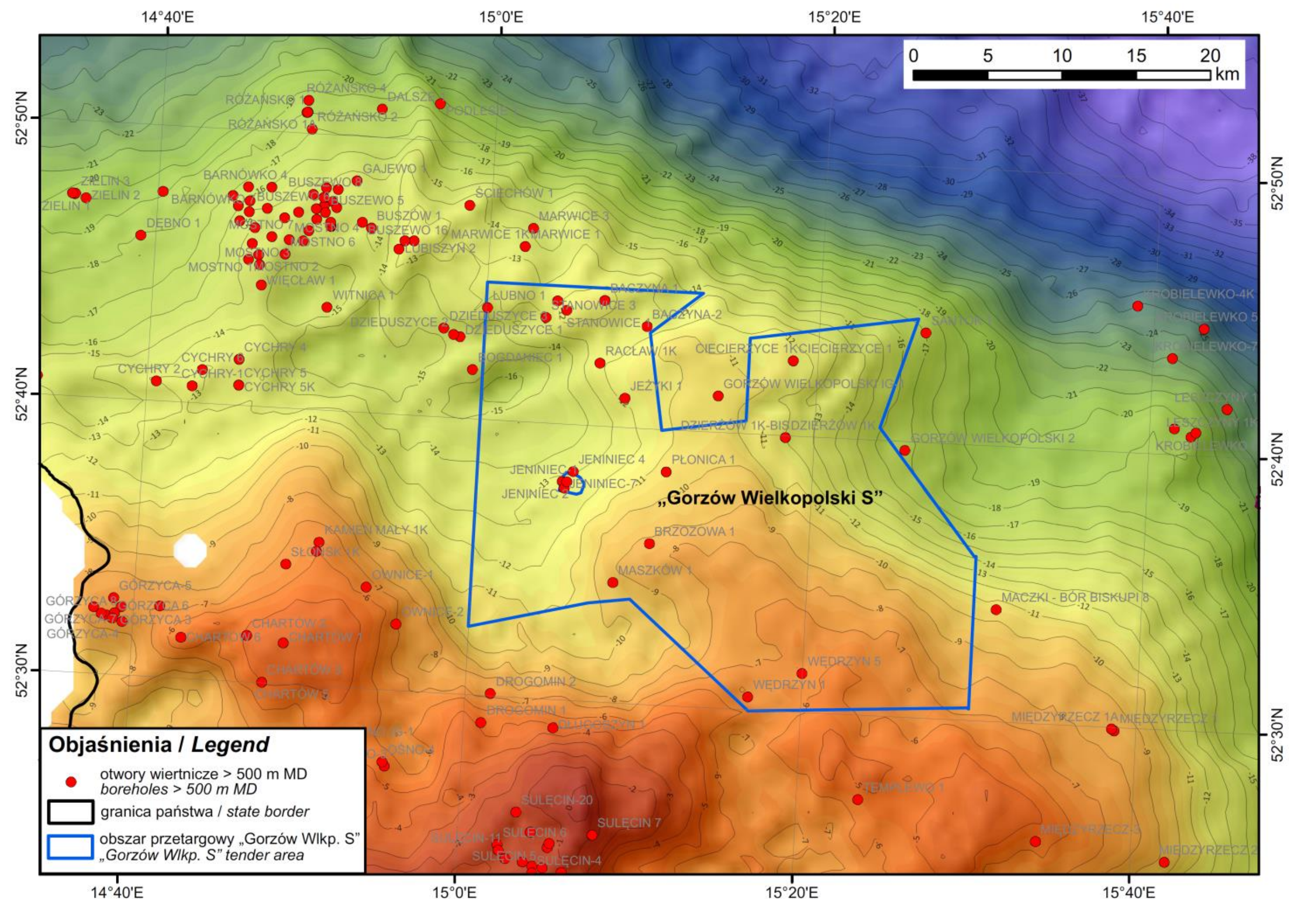


Fig. 7.2. Location of the "Gorzów Wielkopolski S" tender area on the Bouguer gravity anomaly map of Poland.

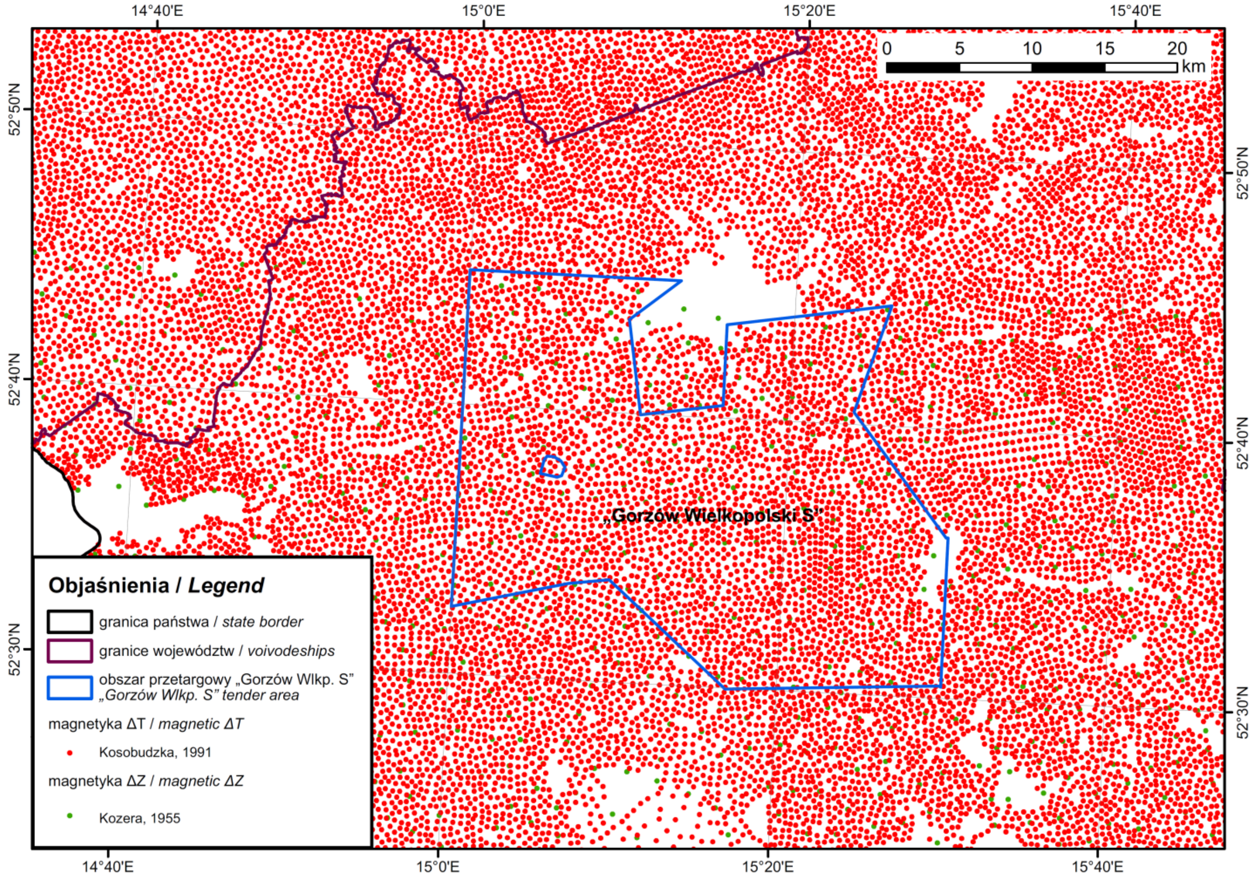


Fig. 7.3. Distribution of magnetic stations in the "Gorzów Wielkopolski S" tender area (based on CGDB, 2021).

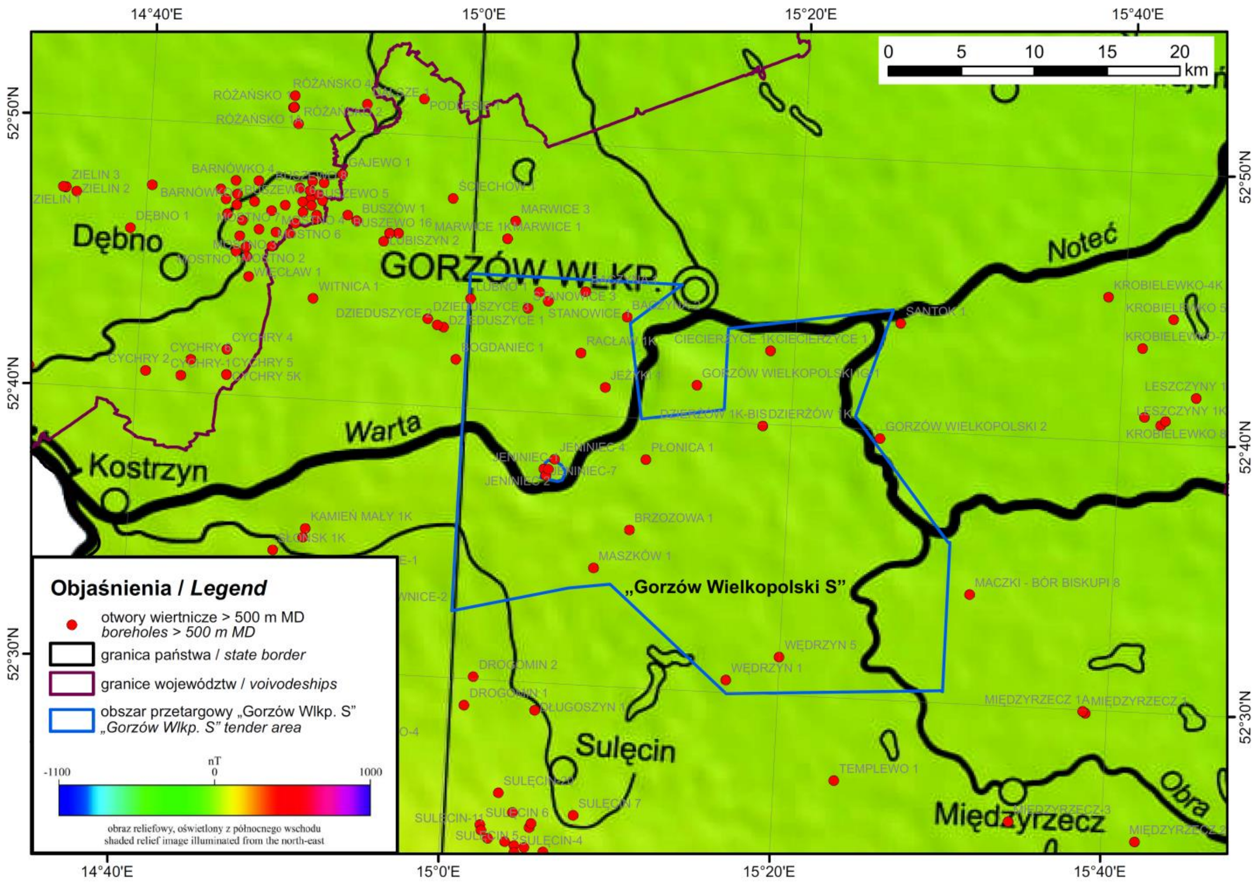


Fig. 7.4. Location of the "Gorzów Wielkopolski S" tender area in the magnetic anomaly map of Poland (Petecki and Rosowiecka, 2017)

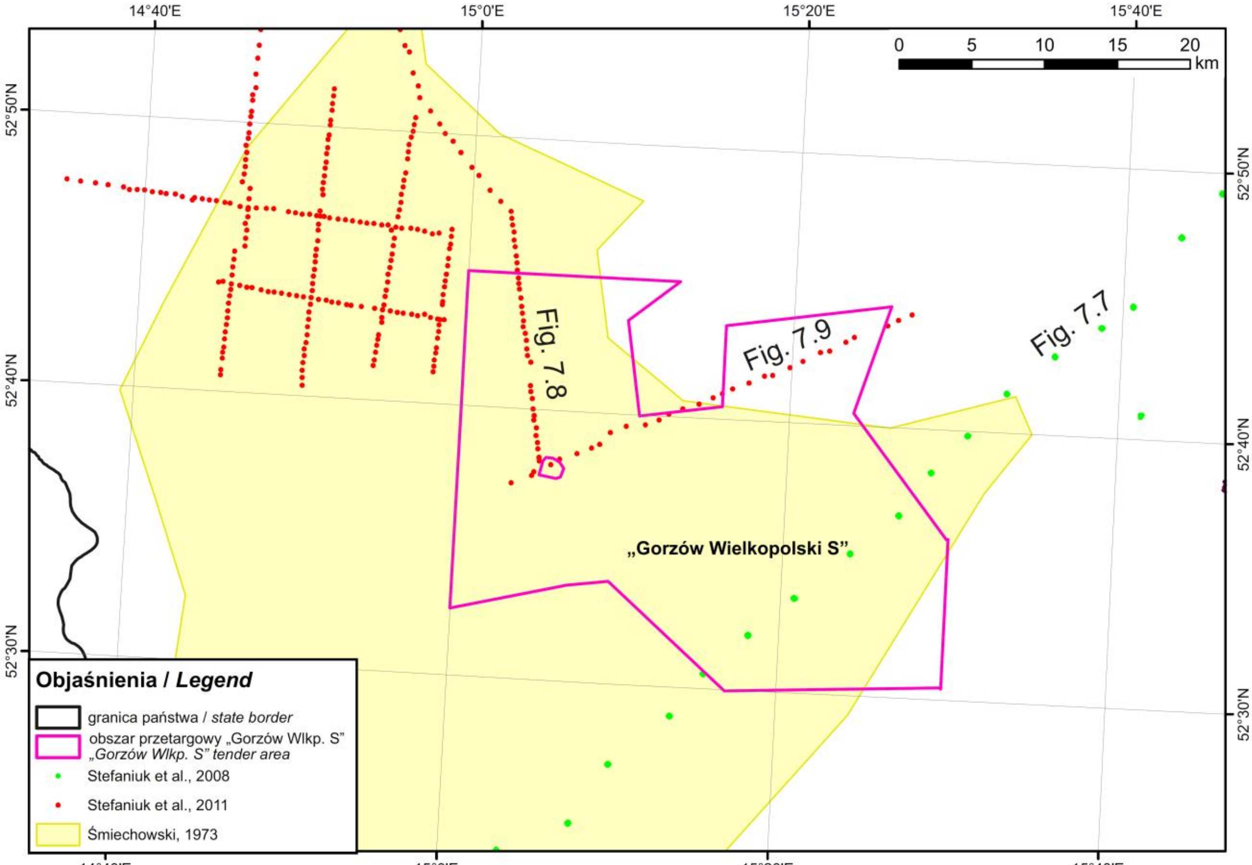


Fig. 7.5. Distribution of magnetotelluric surveys in the "Gorzów Wielkopolski S" tender area (based on CGDB, 2021).

8. SUMMARY CHART

General information:	**Tender area:**	**GORZÓW WIELKOPOLSKI S**
	Location:	Onshore Hydrocarbon concession blocks: 183 Administrative location: Lubuskie voivodeship: Gorzów Wielkopolski City county, commune: Gorzów Wielkopolski (3.71%); Gorzów Wielkopolski county, communes: Lubiszyn (1.61%), Witnica (2.81%), Bogdaniec (15.46%), Deszczno (22.28%), Santok (1.73%); Sulęcin county, communes: Krzeszyce (16.69%), Lubniewice (8.45%); Międzyrzecz county, communes: Skwierzyna (6.68%), Bledzew (20.58%)
	Concession type:	prospection and exploration of hydrocarbon deposits and production of hydrocarbons from a deposit
	Time:	concession for 30 years, including: prospection and exploration phase (5 years), production phase – after investment decision
Participation:		winner of the tender 100%
Acreage [km^2]:		691.38
Accumulation type:		conventional for oil and gas
Structural stages:		Cenozoic Laramide Variscan
Petroleum plays:		I. Upper Permian/Zechstein – Main Dolomite
Reservoir rocks:		I. Main Dolomite dolomitized grainstones and packstones
Source rocks:		I. Main Dolomite mudstones, boundstones, packstones and grainstones
Seal rocks:		I. Zechstein evaporites from base and top
Trap type:		I. Structural, lithological, mixed
Oil and gas fields in the neighborhood		Jeniniec (NR4941), Stanowice (GZ9505), Dzieduszyce (NR10584), Krobielewko (GZ19116)
Seismic surveys (owner):		1975 Międzyrzecz – Nowy Tomyśl 2D, 2 lines (State Treasury) 1976 Skwierzyna – Nowa Sól 2D, 2 lines (State Treasury) 1976 Kostrzyń – Skwierzyna 2D, 2 lines (State Treasury) 1977 Sulęcin – Świebodzin 2D, 6 lines (State Treasury) 1978 Kostrzyń – Gorzów Wielkopolski 2D, 11 lines (State Treasury) 1978-1979 Myślibórz – Krzyż 2D, 78 lines (State Treasury) 1984 Chociwel – Czaplinek 2D, 1 line (State Treasury) 1987 Kostrzyń 2D, 1 line (State Treasury) 1987-1988 Chojna – Gorzów Wlkp. – Strzelce Krajeńskie 2D, 5 lines (State Treasury) 1989-1993 Chojna – Gorzów Wlkp. – Strzelce Krajeńskie 2D, 15 lines (Private inv.) 1993-1996 Dzieduszyce – Gorzów Wlkp. – Lubniewice 2D, 57 lines (Private investor) 1994-1997 Sulęcin – Międzyrzecz 2D, 14 lines (Private investor) 1998 Gorzów Wielkopolski – Międzychód 2D, 7 lines (Private investor) 1999-2000 Międzyrzecz – Międzychód, 6 lines (Private investor) 1997 Dzieduszyce – Stanowice 3D (Private investor) 2000 Gorzów Wielkopolski – Santok 3D (Private investor) 2001 Nowa Wieś – Templewo 3D (Private investor) 2005 Wędrzyn 3D (State Treasury) 2013 Sulęcin 3D (State Treasury) 2014 Maszków – Bolemin 3D (State Treasury)
Wells (depth):		Baczyna 1 (3204.0 m), Baczyna-2 (3167.0 m), Brzozowa 1 (3218.0 m), Ciecierzyce 1/1K (3092.0/3017.0 m), Dzierżów 1K/1K-BIS (3130.0/3040.0 m), Jeniniec 4 (3290.0 m), Jeżyki 1 (3401.0 m), Lubno 1 (3217.0 m), Maszków 1 (3168.0 m), Płonica 1 (3353.0 m), Racław 1K (3256.0 m), Stanowice 1 (3200.0 m), Stanowice 2 (3200.0 m), Stanowice 3 (3261.0 m), Wędrzyn 1 (3170.0 m), Wędrzyn 5 (3210.0 m)

Possible minimum work program for prospection and exploration phase

- Archival data reinterpretation and analysis

- Conducting sesmic survey 2D (80 km SP) or 3D (50 km^2)
  or
  2D seismic data reprocessing 2D (80 km)

- drilling of one well of max. depth 4000 m b.g.l. reaching the Permian basement with obligatory coring of prospective intervals

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