

Poland as European shale gas laboratory: status and experiences



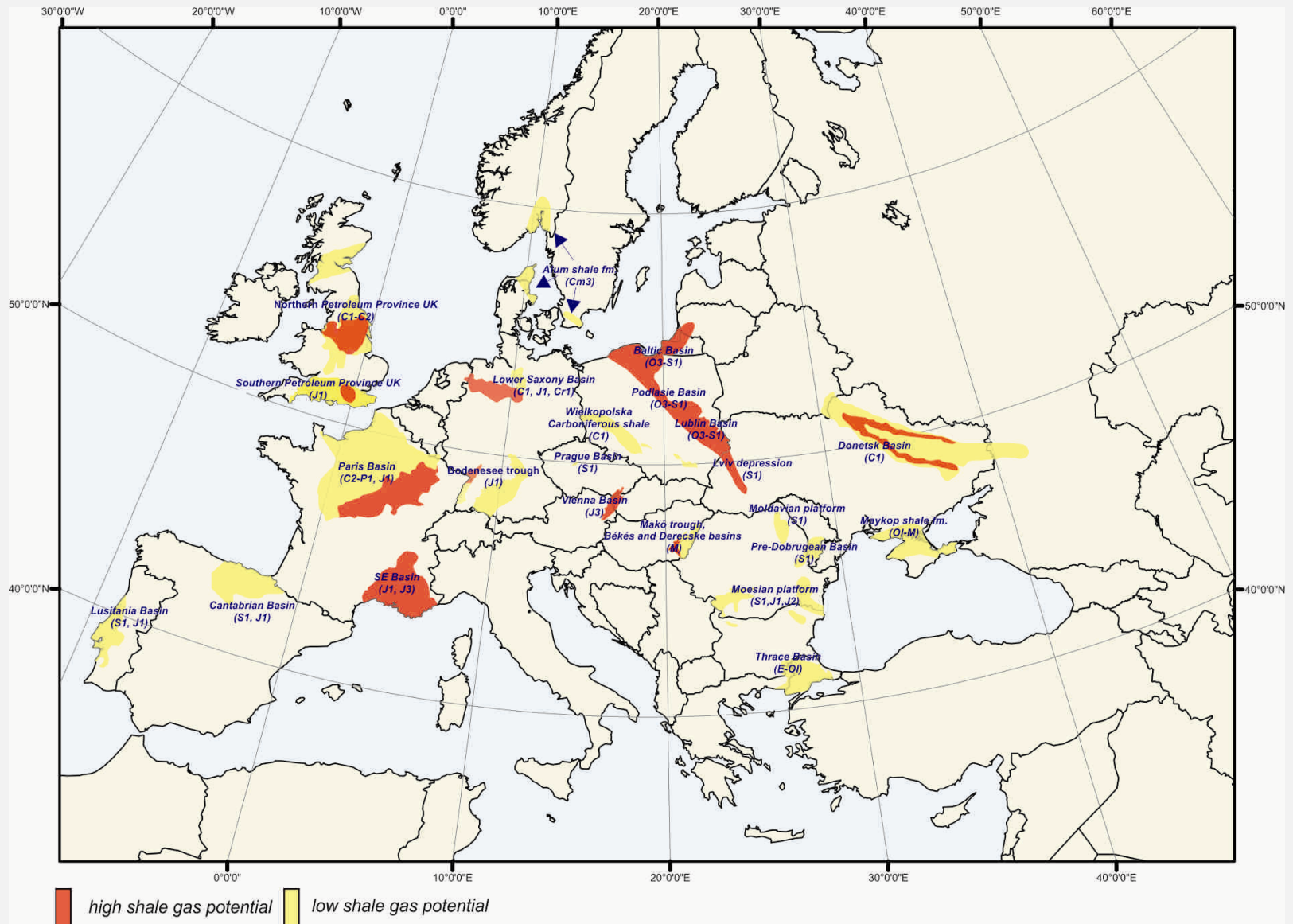
4th International Geosciences Student Conference, Berlin,

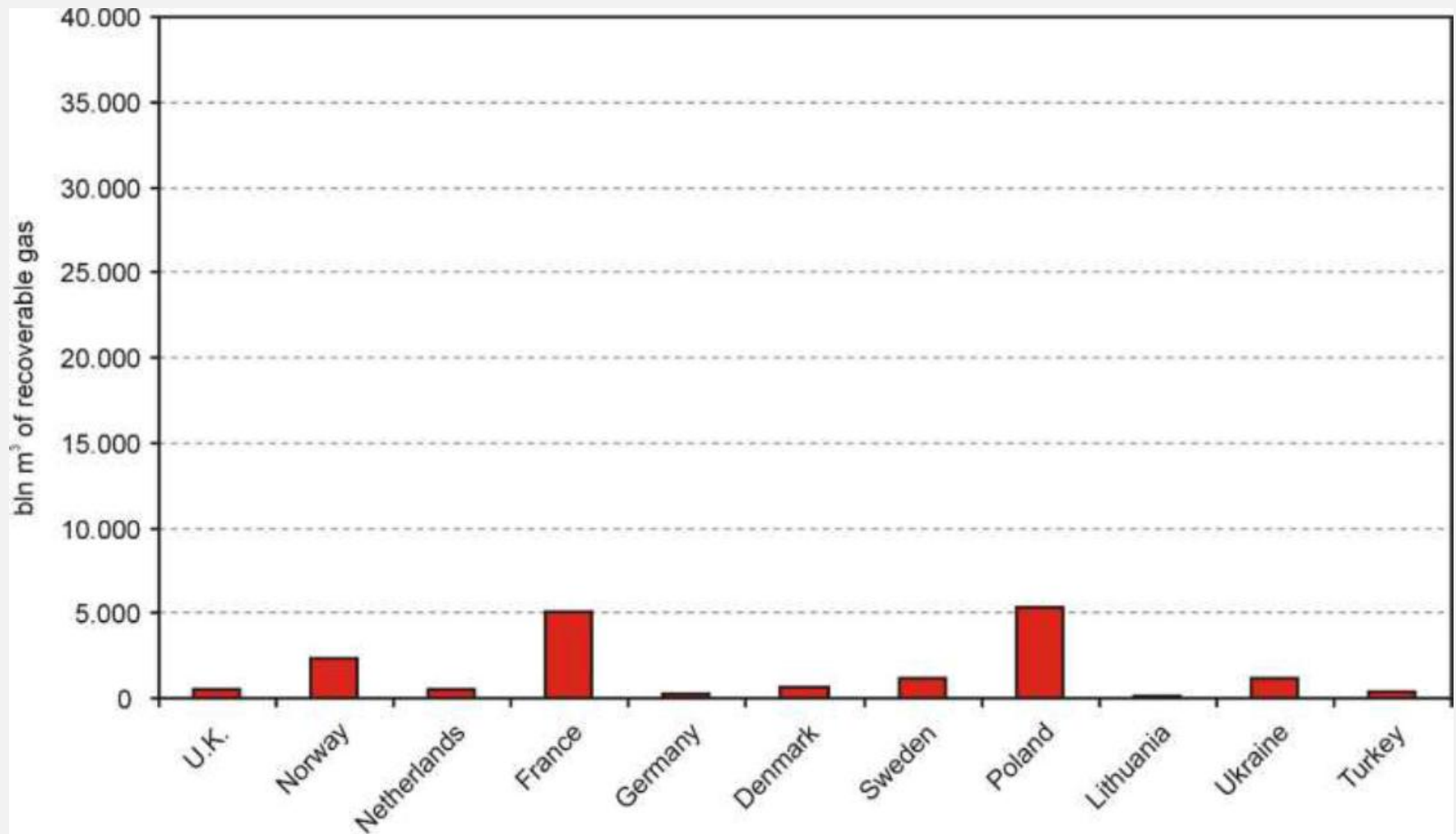
26th April, 2013

Ireneusz Dyrka M.Sc., Eng. (PGI-NRI)

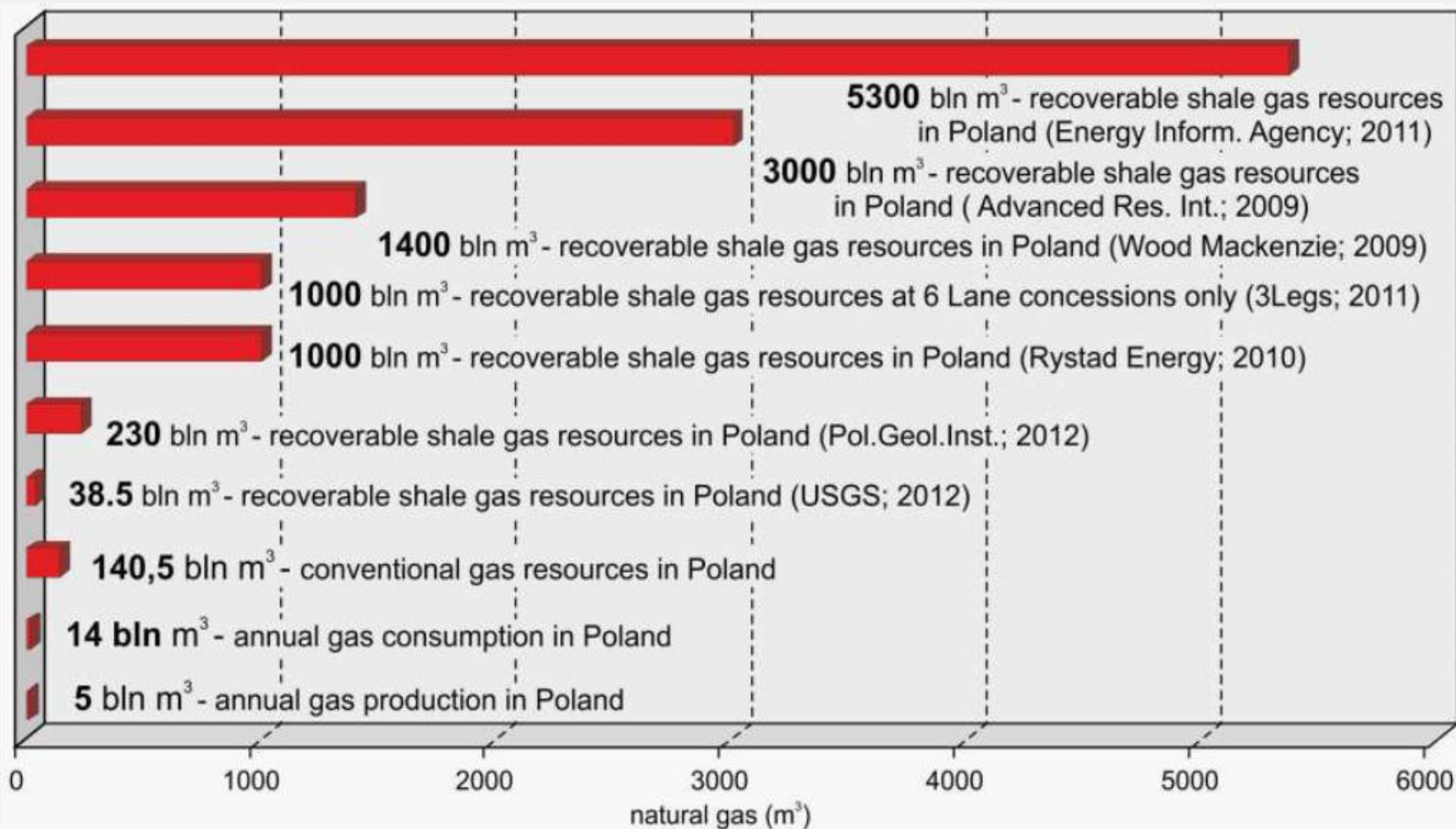
Marcin Janas M.Sc., Eng. (PGI-NRI)

Shale Gas Basins in Europe

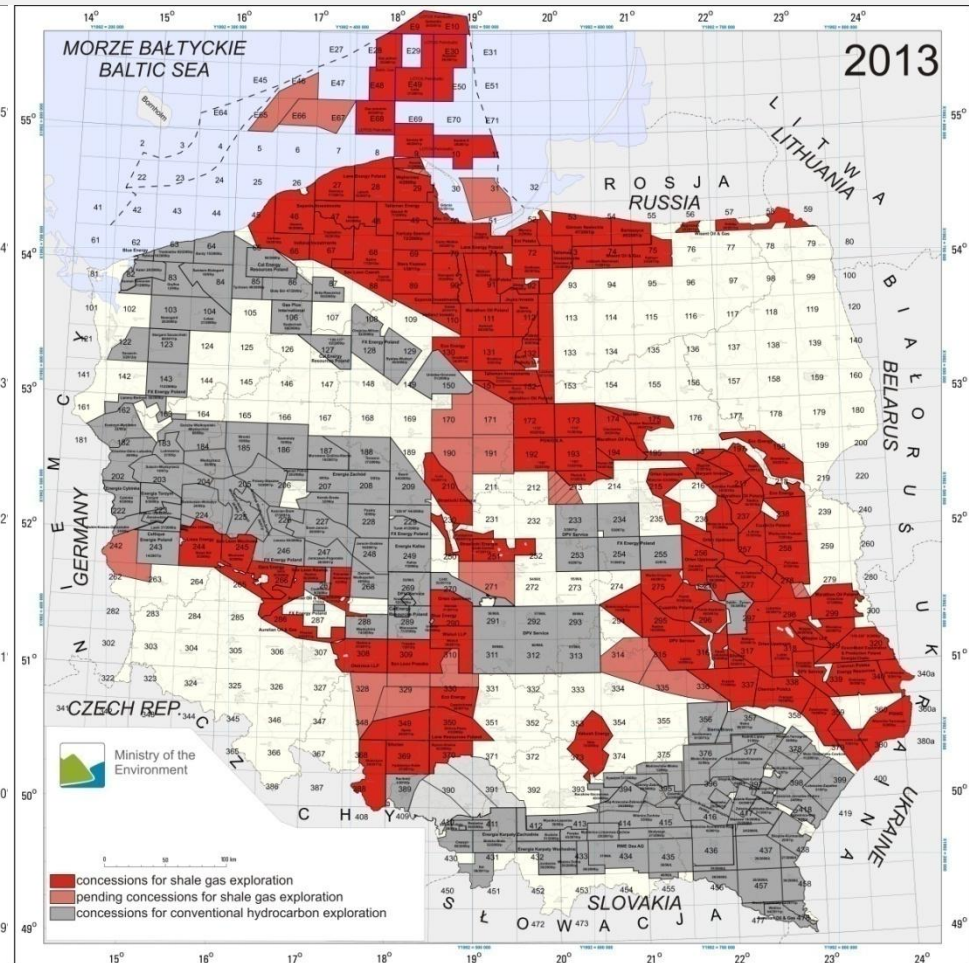
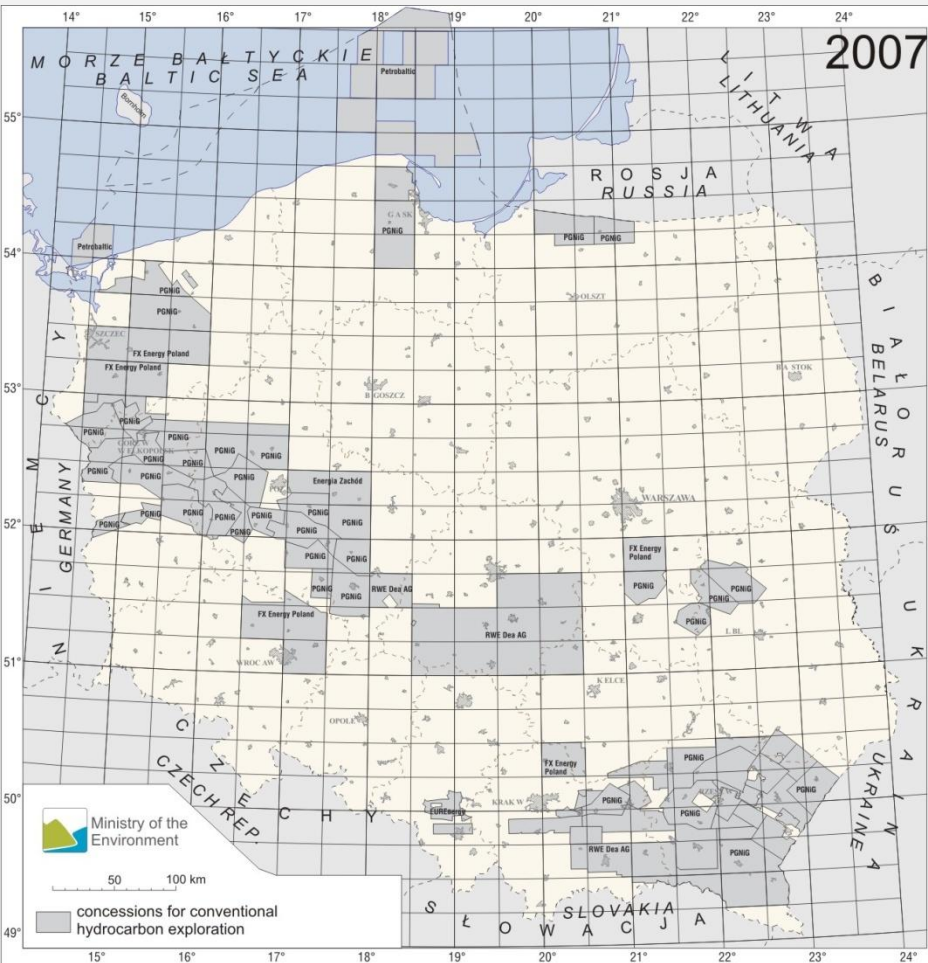




Shale gas resources (EIA report; In: Poprawa, 2012)



Compilation of potentially recoverable resources of Lower Paleozoic shale gas in Poland, according to preliminary estimations by Wood Mackenzie and Advanced Resources International, and recoverable conventional gas resources, annual production of conventional gas and annual gas consumption in Poland (Poprawa, 2012)



Maps of cocessions status for hydrocarbon exploration in Poland (Bońda R., Siekiera D. and Szufflicki M.; source: Polish Ministry of Environment, Department of Geology and Geological Concessions)

Major oil & gas companies holding shale gas exploration concessions in Poland

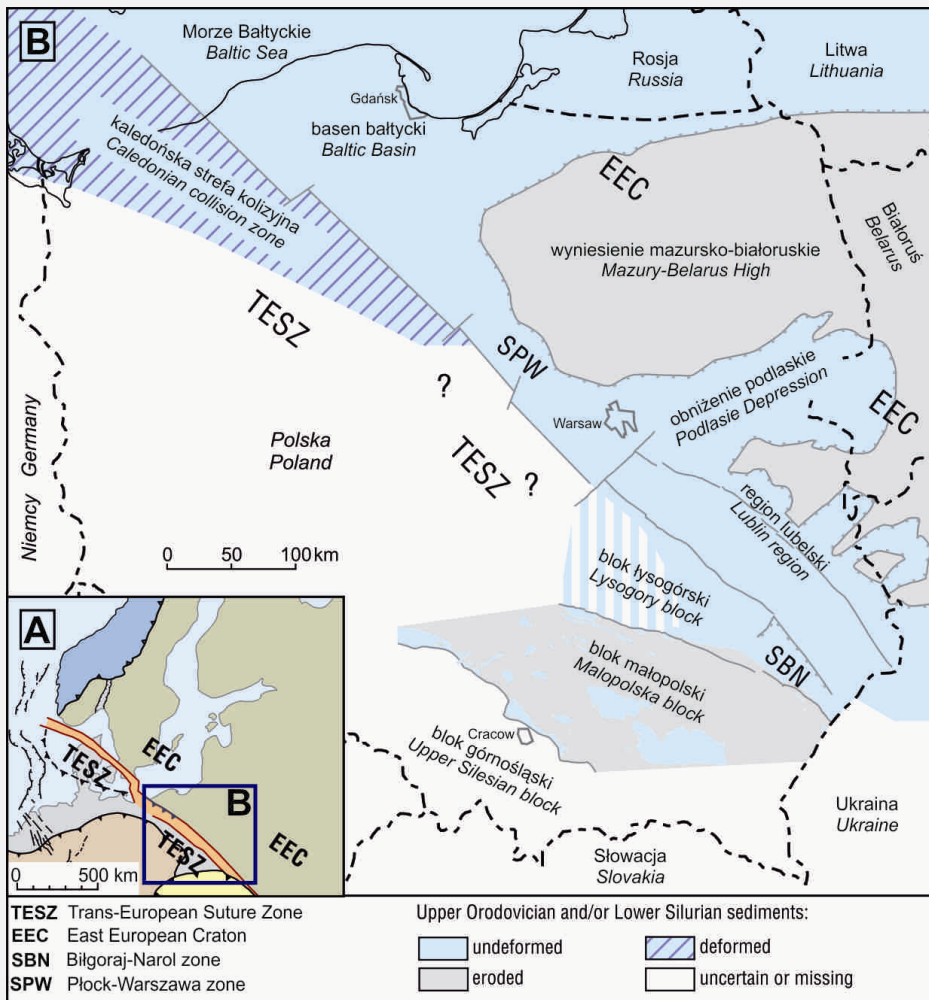


GEOLOGY OF THE LOWER PALEOZOIC SHALES IN POLAND



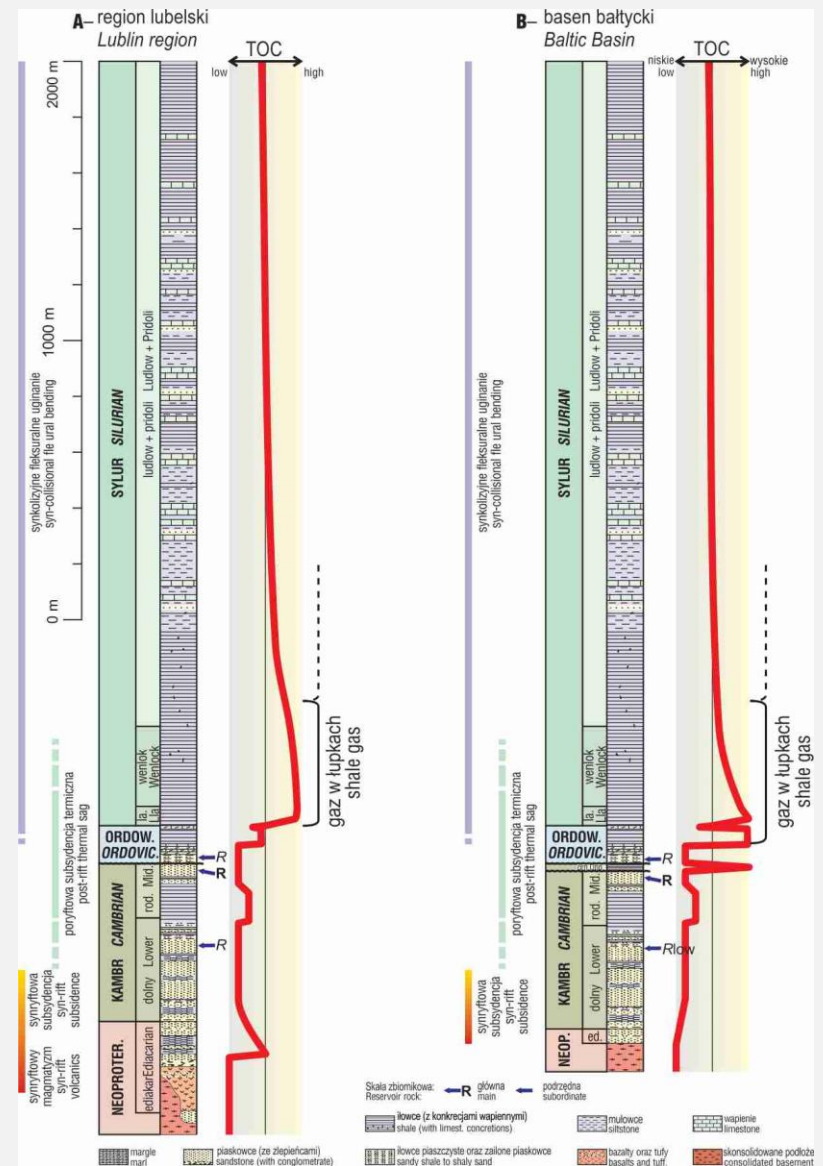
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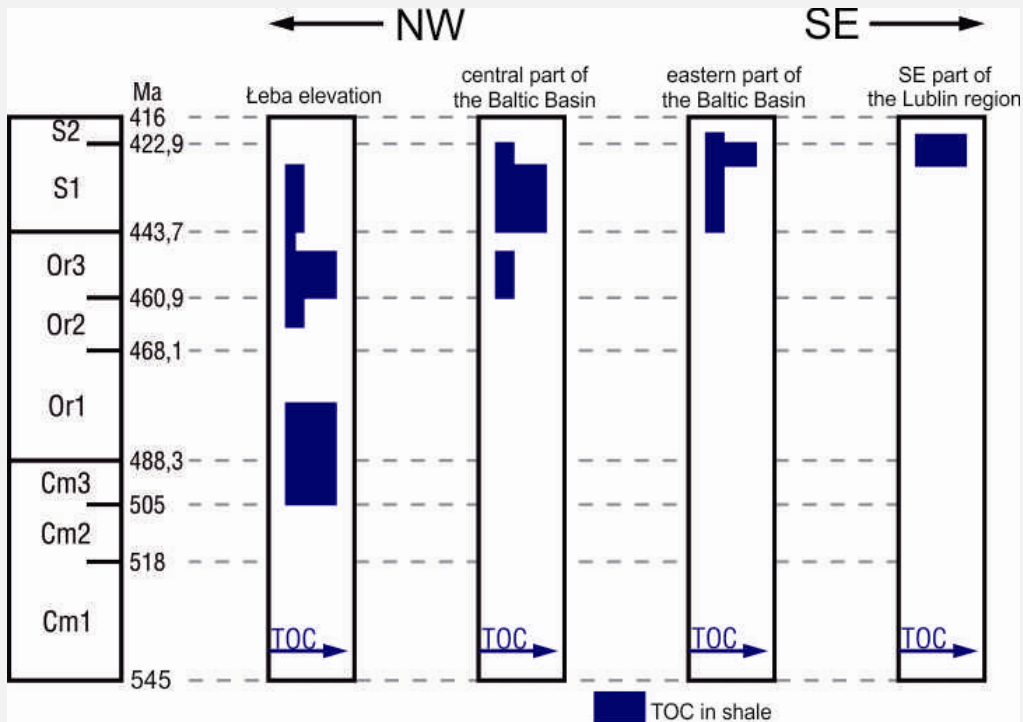


A – western slope of the East European Craton (EEC) with the background of the main tectonic units of the central and northern Europe.

B – location of the Lower Paleozoic sedimentary basins and lateral estend of the Upper Ordovician and/or Lower Silurian shale formations. SPZ – Płock-Warszawa zone, SBN – Biłgoraj-Narol zone (after Poprawa, 2010).



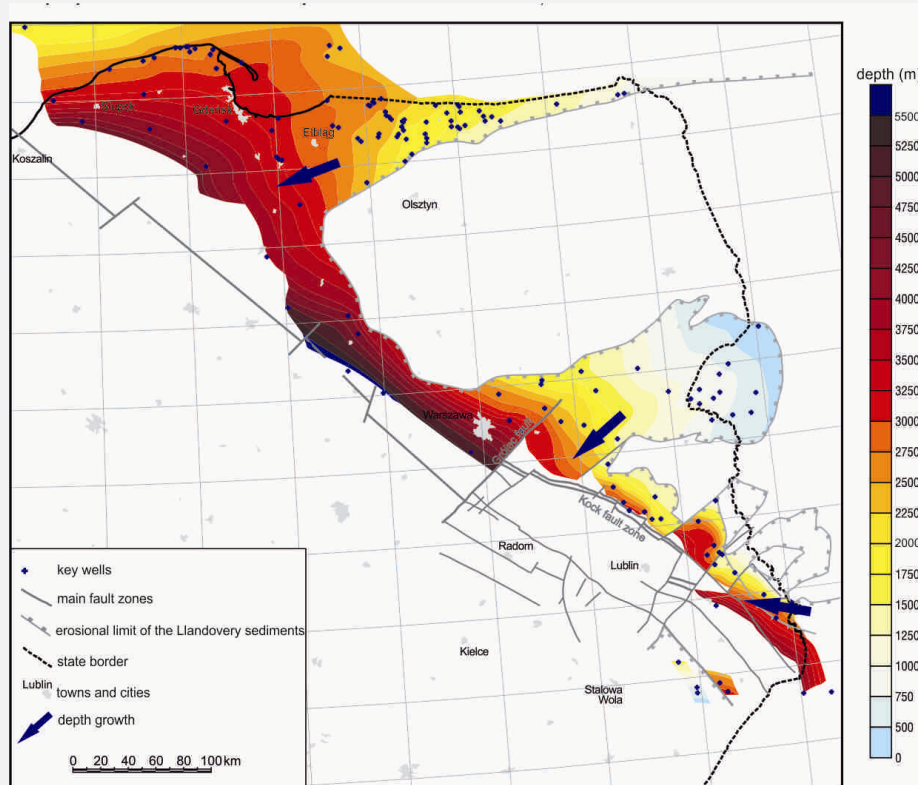
Simplified lithostratigraphic section of the Lower Paleozoic in the Lublin region (A), and Baltic Basin (B) with position of organic rich shales, being potential shale gas formation (after Poprawa, 2010).



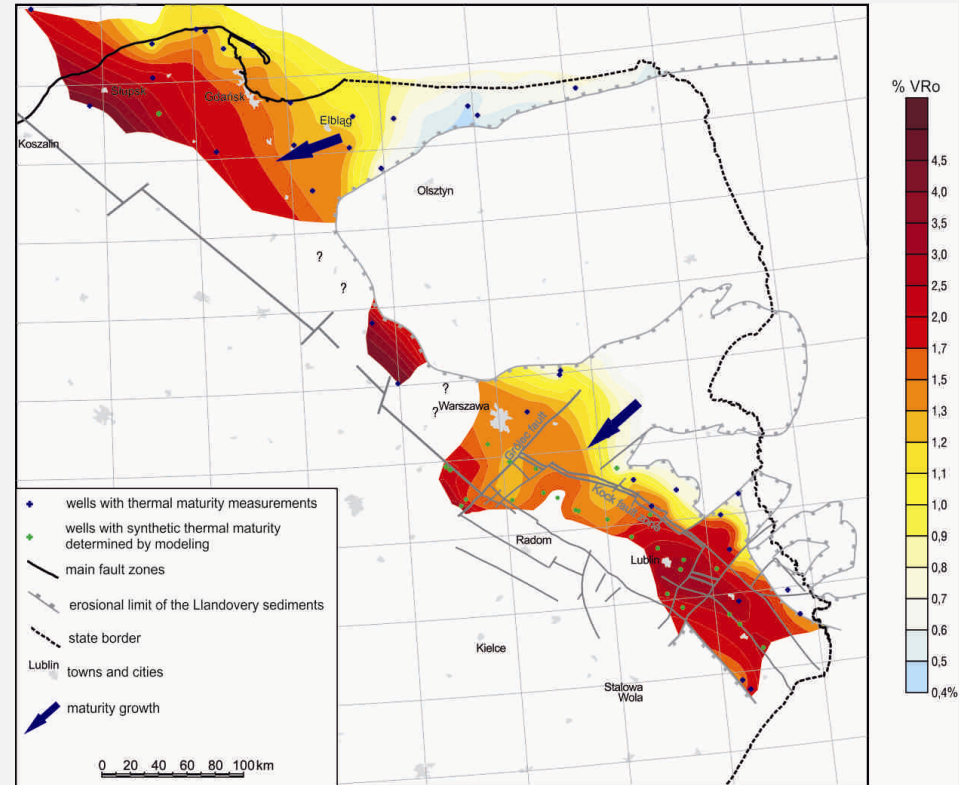
- Important feature of Lower Paleozoic plays is their diachronism of the first appearance of organic rich shale in sedimentary basin.
- The closer to SE part of Poland prospective of Lower Paleozoic shales are more younger.

Simplified scheme illustrating diachronism of the first appearance of organic rich shales in sedimentary basins from the western slope of the EEC in the Early Paleozoic times (Poprawa, 2010)

The relationship between burial depth and thermal maturity



Map of the depth to the base of the Llandovery (base of Silurian) at western slope of the East European Craton (after Poprawa, 2010)



Map of thermal maturity (vitrinite reflectance scale %Vro) for Llandovery (Lower Silurian) sediments at the western slope of the East European Craton (after Poprawa, 2010)

ASSESSMENT OF SHALE GAS AND OIL RESOURCES OF THE LOWER PALEOZOIC BALTIC-PODLASIE-LUBLIN BASIN IN POLAND *First Report*



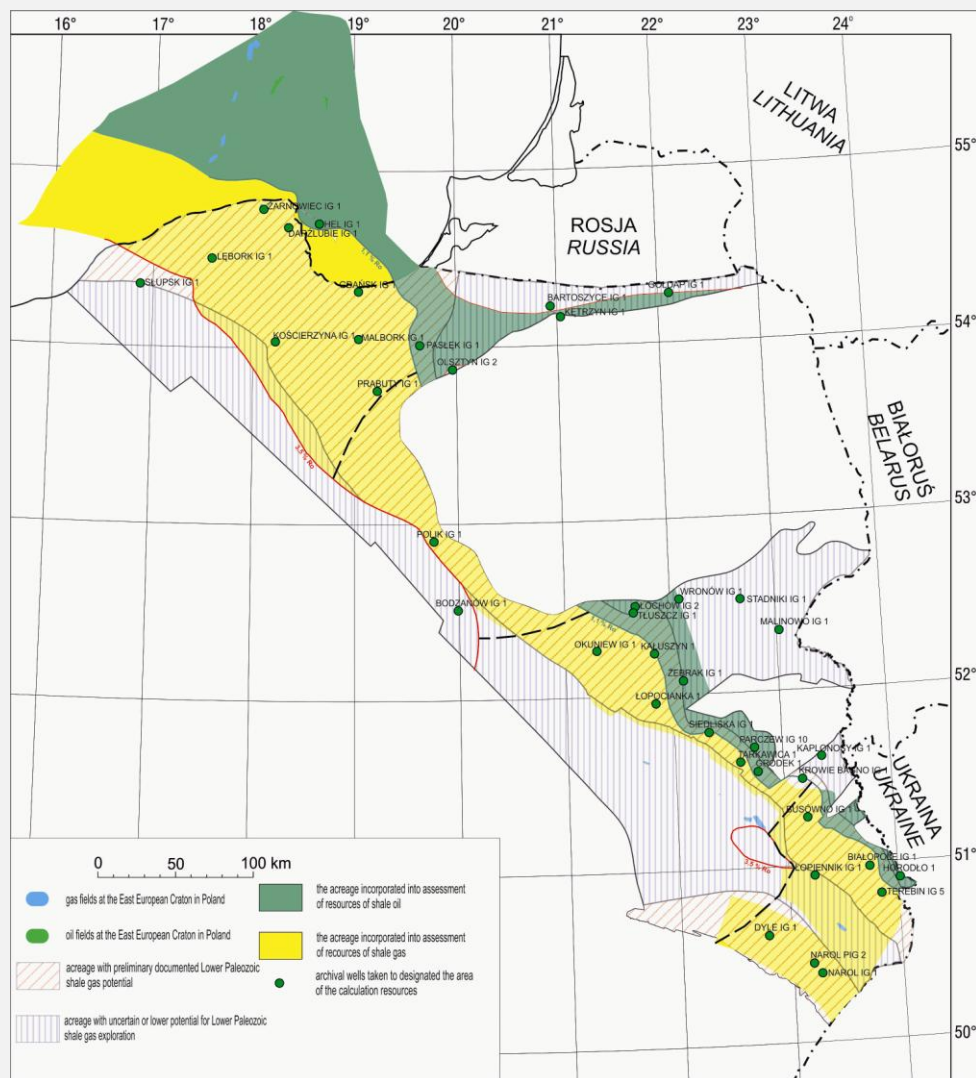
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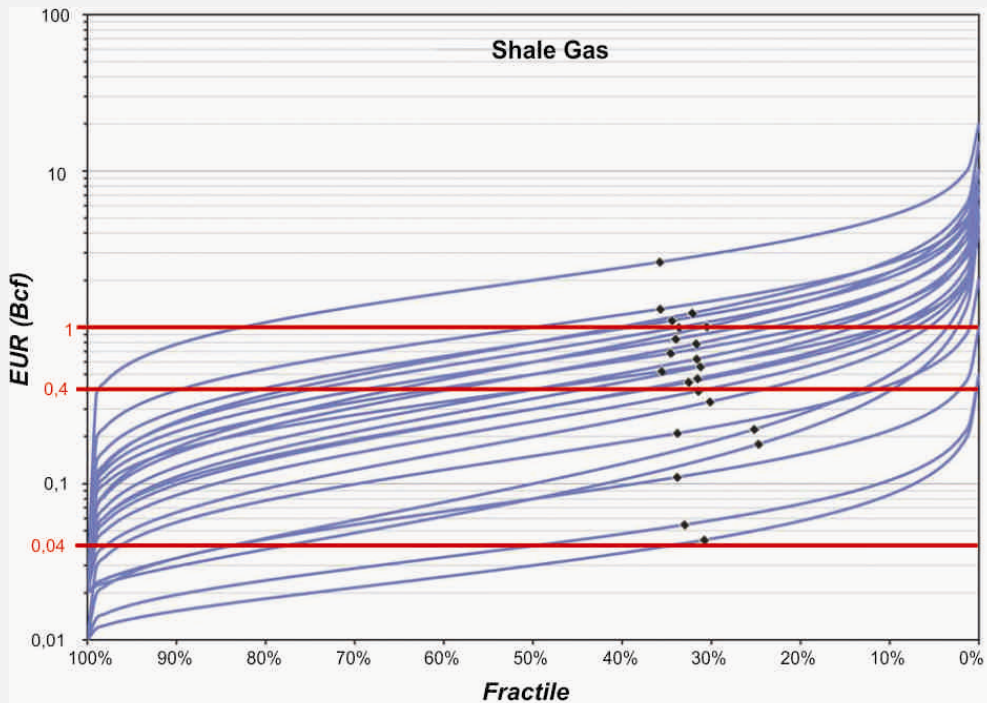
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- ❑ Recoverable resources were calculated with use of a certain average Estimated Ultimate Recovery (EUR) – USGS methodology.
- ❑ Assessment of shale gas and shale oil resources of the Lower Paleozoic resources based on geological data from 39 wells, such as :
 - burial depth (1000-4500 m)
 - lateral extend and net thicknesses (>15 m)
 - organic matter (TOC content >1%)
 - thermal maturity (0,5-1,1 % oil; 1,1-3,5 % gas)
 - structural complexity
- ❑ Data like porosity, permeability, gas pressure, HC composition, IP, mechanical properties and shale mineralogy were not available.



The acreage incorporated into assessment units and qualified into calculation of resources of shale gas and oil





Three alternative EURs were incorporated:

- 0,4 Bcf (11,3 MMcm) as the most probable
- 1 Bcf (28,3 MMcm) as maximum
- 0,04 Bcf (1,13 MMcm) as minimum

Distribution of Estimated Ultimate Recovery from a single well for 26 U.S. sedimentary basins or areas analyzed at angle of USGS resources. A single blue line represents distribution of EUR in certain U.S. sedimentary basin. Red line indicate value of EUR which have been adopted in the assessment of shale gas in Poland by the PGI-NRI in variant minimum, median and maximum. (based on: U.S. Geological Survey Oil and Gas Assessment Team, 2012).

Recoverable resources of shale gas in the Lower Paleozoic basin. Bcf – billion cubic feet. Bcm– billion cubic meters. EUR – Estimated Ultimate Recovery. PGI Report, 2012.

PGI Report, 2012	EUR minimum (0.04 Bcf = 1.13 MMcm)	EUR optimum (0.4 Bcf = 11.3 MMcm)	EUR maximum (1 Bcf = 28.3 MMcm)
offshore acreage max. 7,952.4 sq.km	14.8 Bcm	148,4 Bcm	371.1 Bcm
offshore acreage min. 6,192.4 sq.km (gas window)	11.6 Bcm	115.6 Bcm	289.0 Bcm
onshore basin acreage max. 33,183.3 sq.km	61.9 Bcm	619.4 Bcm	1,548.6 Bcm
onshore basin acreage min. 12,347.3 sq.km (gas window)	23.0 Bcm	230.5 Bcm	576.2 Bcm
onshore & offshore acreage max. 41,135.7 sq.km	76.8 Bcm	767.9 Bcm	1,919.7 Bcm
onshore & offshore acreage min. 18,539.7 sq.km (gas window)	34.6 Bcm	346.1 Bcm	865.2 Bcm

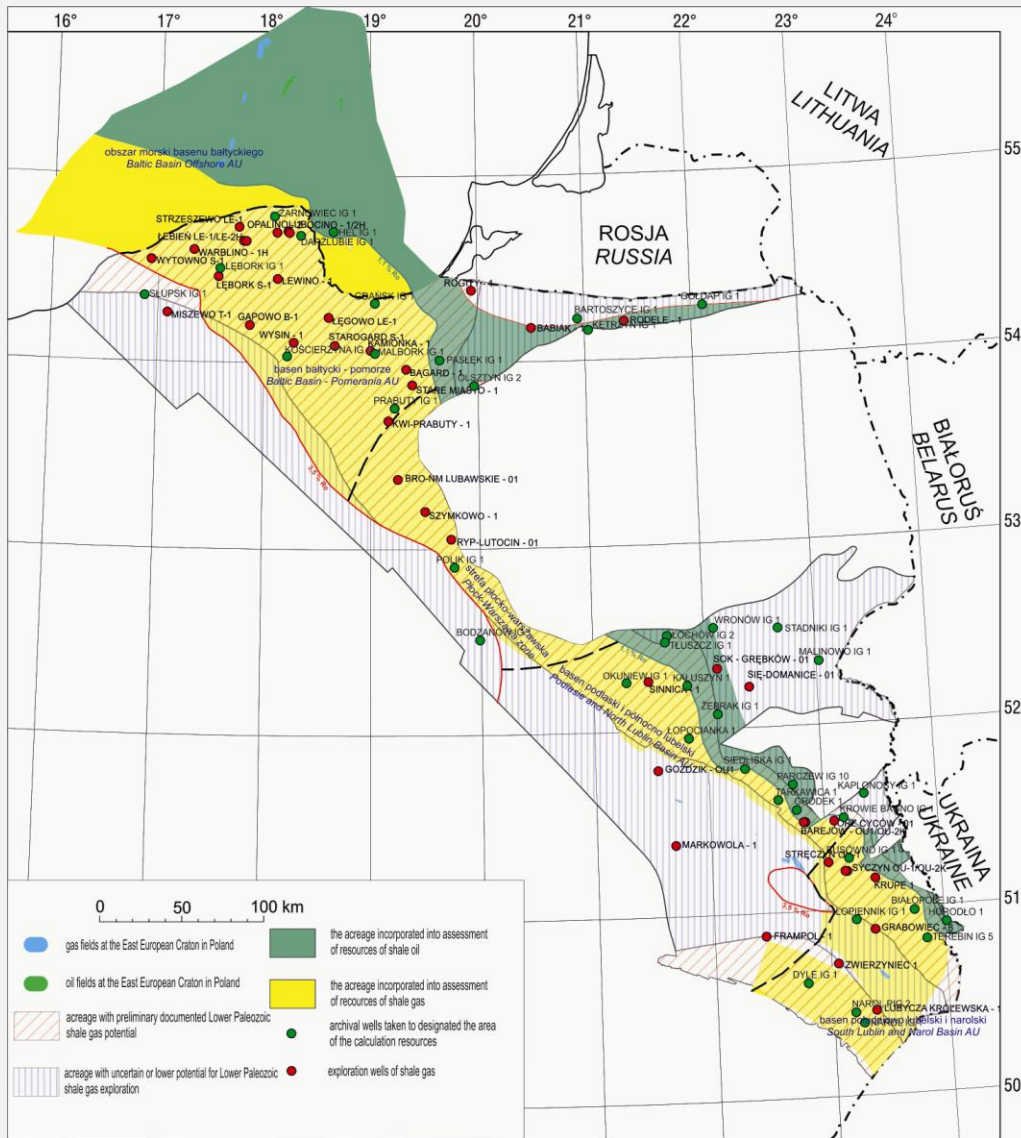


FUTURE ASSESSMENT OF SHALE GAS RESOURCES OF THE LOWER PALEOZOIC BALTIC-PODLASIE-LUBLIN BASIN IN POLAND



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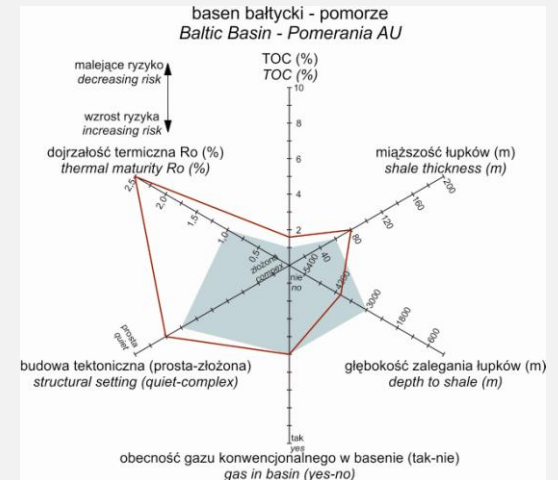
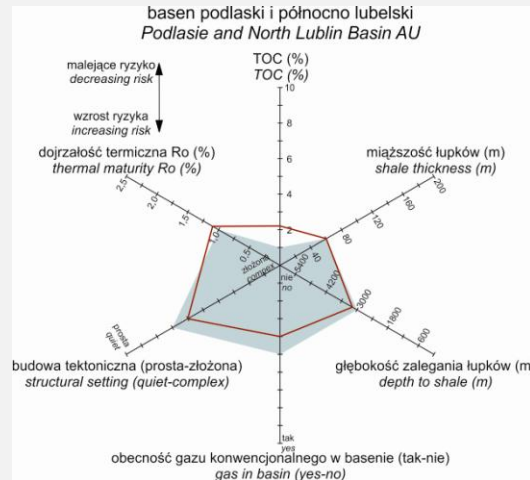
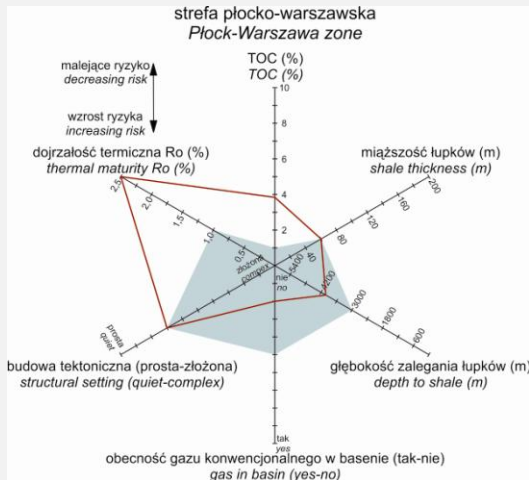
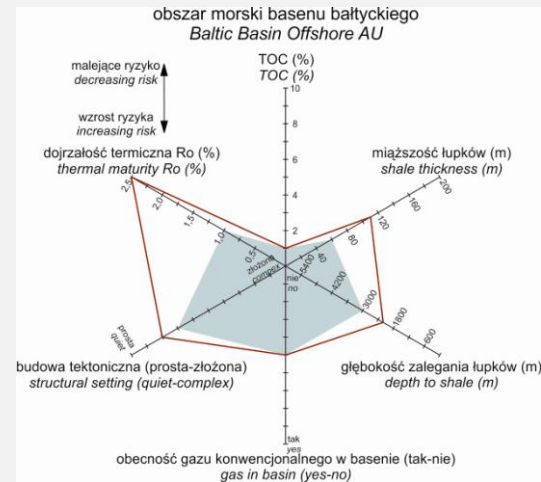
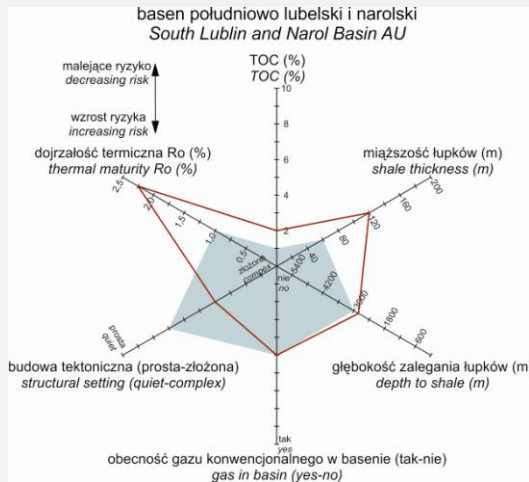
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- Baltic Basin Offshore AU
 - Baltic Basin – Pomerania AU
 - Płock-Warszawa zone AU
 - Podlasie and North Lublin Basin AU
 - South Lublin and Narol Basin AU
- AU – Assessment Unit



Geological and geochemical risk parameters of shale gas exploration for proposed future assessment unit.



wartości w zakresie wysokiego ryzyka
 values in high risk zone

zakres typowych średnich stwierdzanych wartości
 values typically average observed in the basin



ENVIRONMENTAL IMPACT OF HYDRAULIC FRACTURING TREATMENT PERFORMED ON THE ŁEBIEŃ LE-2H WELL

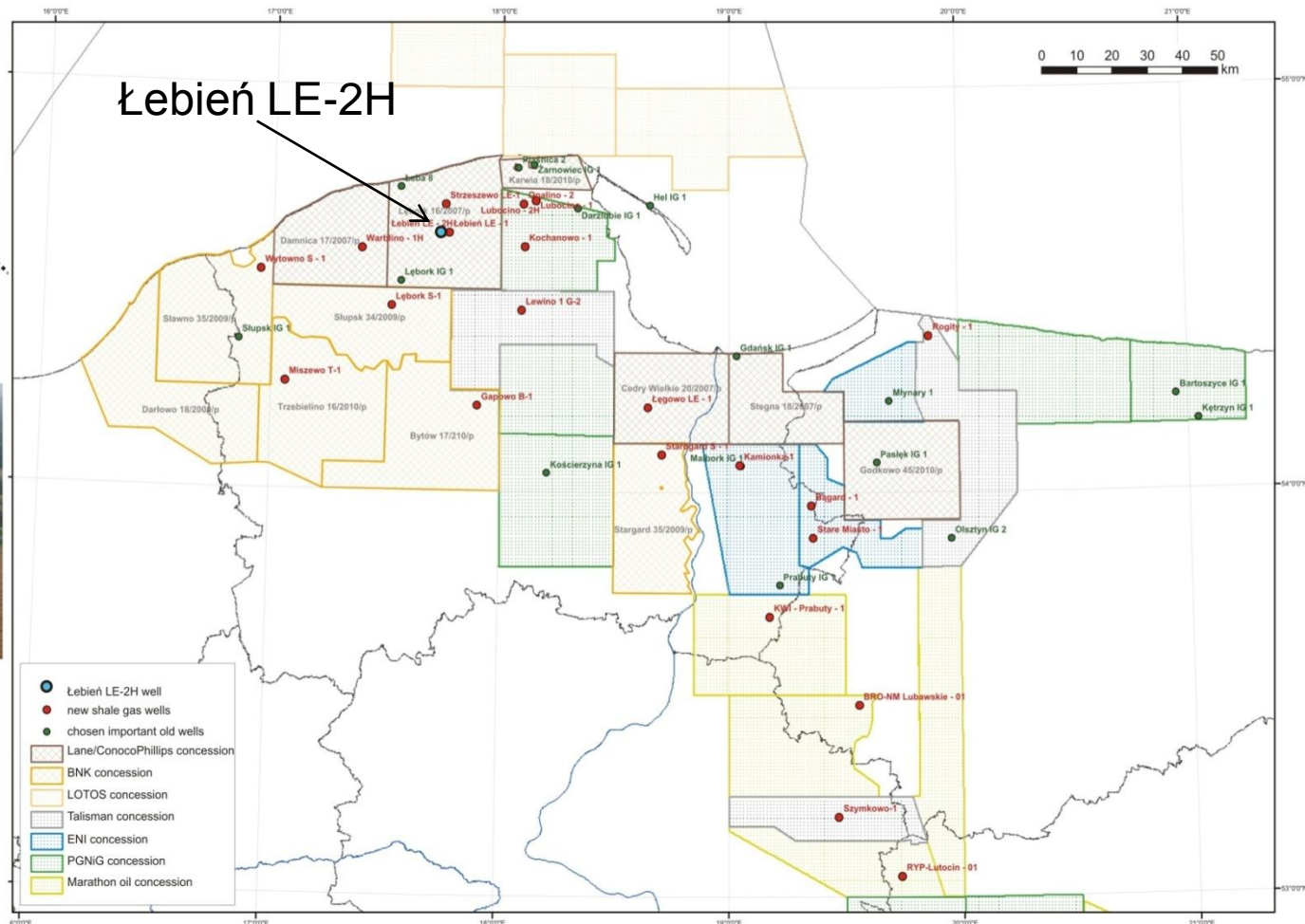


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Łebień LE-2H wellsite (source: 3legsresources)



Map showing location of Łebień LE-2H well and cocessions status for shale gas exploration within the polish land sector of Baltic Basin (created by Jasionowski, PGI)



THE ŁEBIEŃ ENVIRONMENTAL REPORT

CONTRACTING AUTHORITY: MINISTRY OF ENVIRONMENT IN AGREEMENT WITH THE OPERATOR

CONTRACTOR: CONSORTIUM LED BY THE PGI-NRI

MAJOR AIM: ASSESS ENVIRONMENTAL IMPACT OF HYDRAULIC FRACTURING TREATMENT PERFORMED ON THE ŁEBIEŃ LE-2H WELL

RESEARCH COMPRISED: SEISMIC MONITORING, ANALYSES OF: SOIL GAS, SURFACE AND GROUND WATER, HYDRAULIC FRACTURING FLUID, MEASUREMENTS OF GASEOUS EMISSIONS AND NOISE



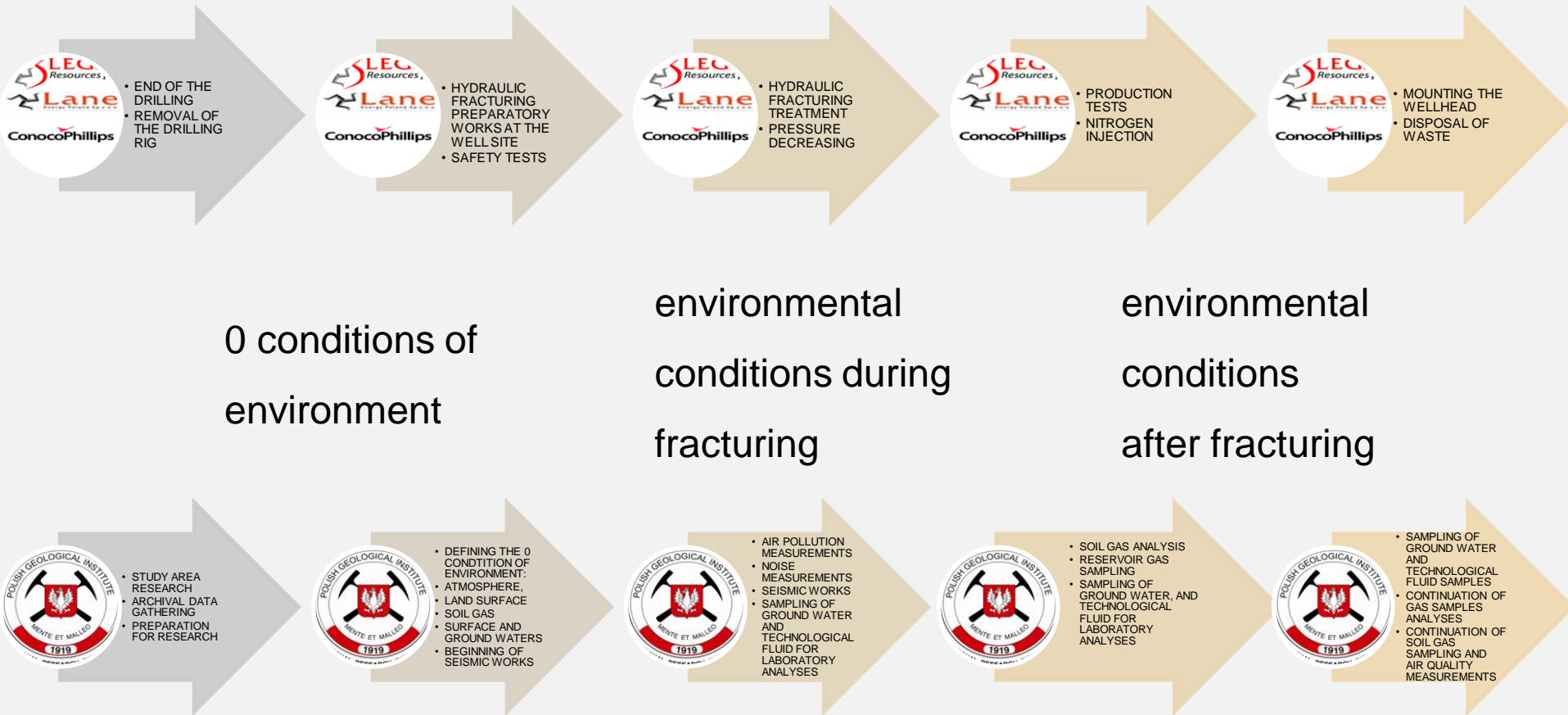
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Plan of the environmental research



RESULTS OF HYDRAULIC FRACTURING TREATMENT

soil gas

NO CHANGES IN COMPOSITION OF RADIOACTIVE RADON OR METHANE IN SOIL GAS

noise

77.5 dB ON THE WELL SITE
53.8 dB IN PROXIMITY OF VILLAGE HOUSES

waste

FLOWBACK FRAC FLUIDS WERE CHARACTERIZED BY SIGNIFICANT CONTENT OF CHEMICALS AND TOXICITY. PART OF THE FLUIDS WERE RECYCLED, ANOTHER PART WAS SENT TO BE SUBJECTED TO SPECIALIZED TREATMENT METHODS

air

THE RELEASED GAS DURING FRAC TREATMENT DID NOT GENERATED AIR POLLUTION AS IT WAS NEUTRALIZED AT WELL FLARE STACK

ground vibrations

DID NOT RESULT IN ANY GROUND VIBRATIONS OR EARTHQUAKES

surface water

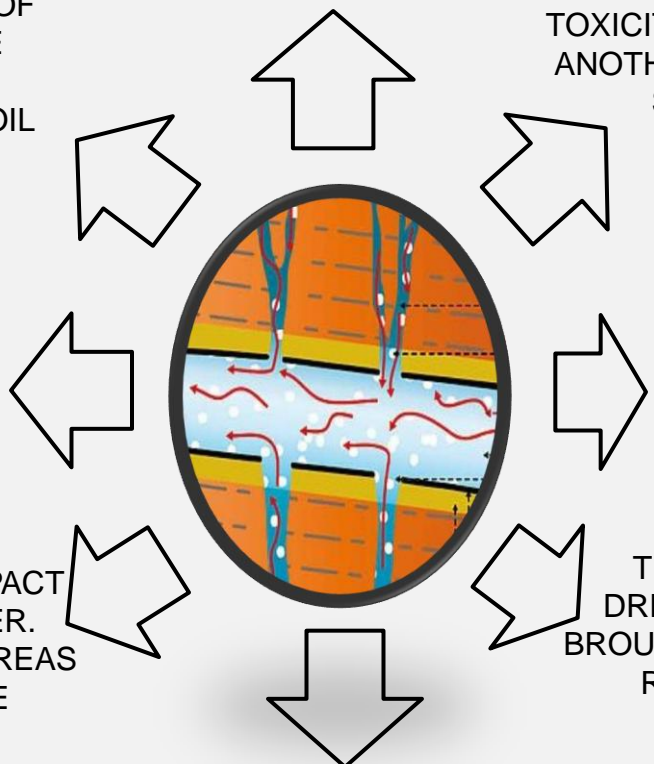
STUDIES DID NOT SHOW ANY IMPACT ON QUALITY OF SURFACE WATER. HYDROLOGICAL CONDITIONS IN AREAS ADJACENT TO THE WELL SITE WERE NOT INFLUENCED

landscape

TEMPORARY LOAD OF THE WHOLE DRILLING EQUIPMENT AND MATERIALS BROUGHT TO THE WELL SITE SEEM NOT TO RESULT IN ANY LARGER CHANGES

ground water

USE OF ALMOST 18.000 m³ OF GROUND WATER FROM THE WATER-BEARING HORIZON DID NOT RESULT IN DECREASE IN GROUND WATER RESOURCES IN THE WELL SITE AREA DUE TO THE FACT THAT WATER WAS GATHERED FOR SEVERAL MONTHS IN SURFACE RESERVOIRS IN QUANTITIES CONSISTENT WITH WATER RIGHTS PERMIT



STATUS OF SHALE GAS EXPLORATION IN POLAND



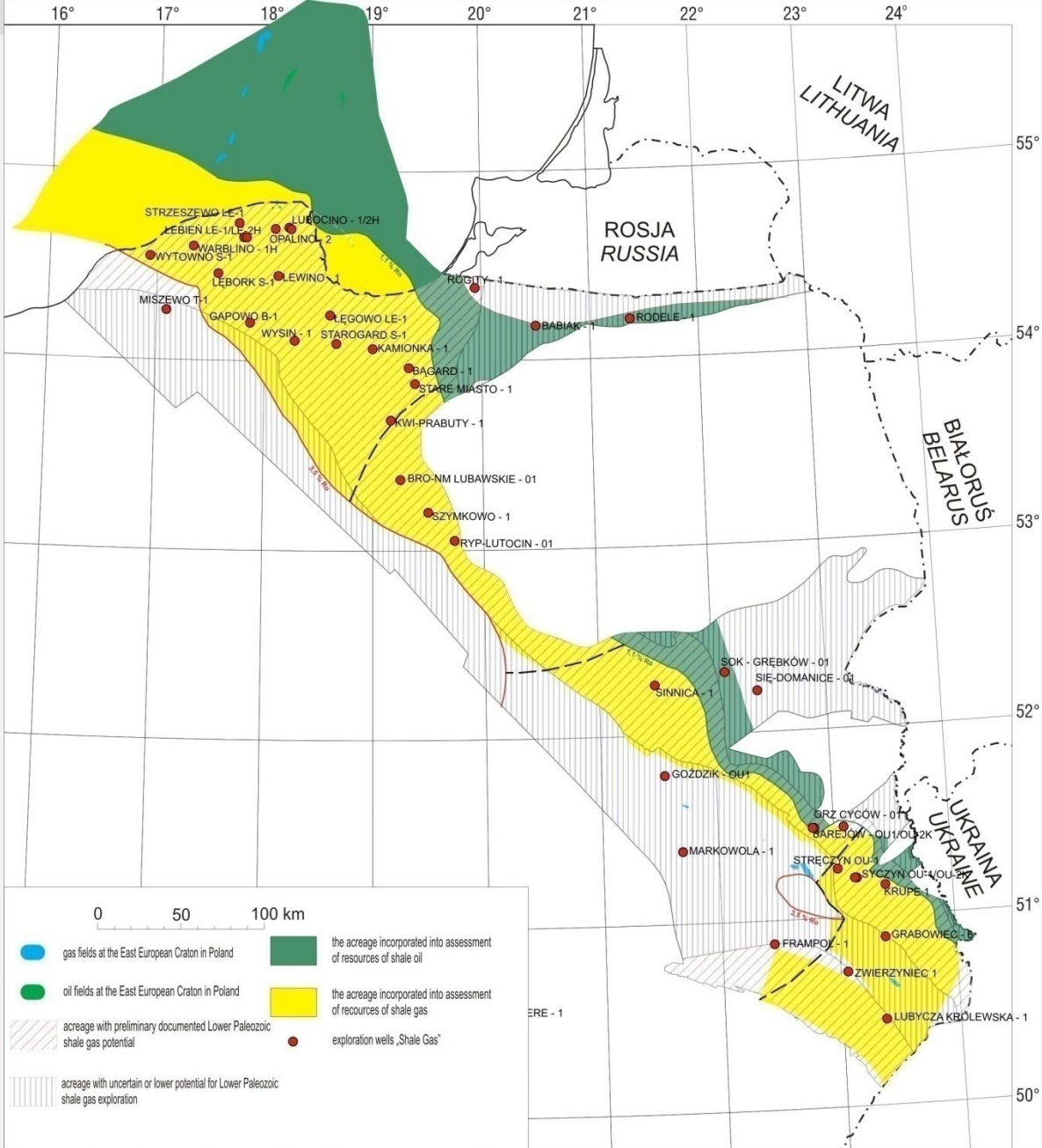
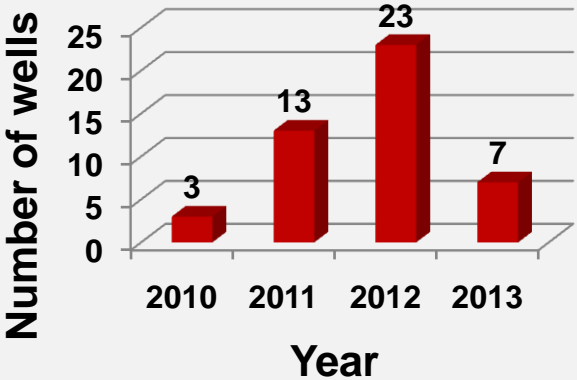
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Table showing up to date (02.04.2013) numbers of completed shale gas wells with and without hydraulic fracturing performed (source: Polish Ministry of Environment)

	number of vertical wells	number of horizontal wells	sum
hydraulic fracturing	9	4	13
microfracturing/DFIT*	4	1	5
without hydraulic fracturing	20	5	25
sum	33	10	43

*DFIT – Diagnostic Fracture injection Test



Map showing all shale gas wells at the East European Craton



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OPTIMISTIC RESULTS PUBLISHED BY LANE/CONOCO PHILLIPS

Łebień LE-2H well - completed September 2011



Well reached 4075 m with horizontal section 1000 m long within Lower Paleozoic shales (13-stage slickwater fracturing)



Tested for 17 days



RESULTS

Flowed at 450-520 mcf/day for 8 day period before being shut in (**First sustained shale gas production in Poland**)



Potential for further fracturing design improvement in new wells



*Fracturing operations and flare at Łebień LE-2H well
(source: 3legsresources)*

Thank you for the attention



„We still don't know. Is the Polish Ordovician-Silurian Shale Gas Basin a honey barrel or just honey smell.”

(Hubert Kiersnowski, Head of Unconventional Resources, PGI-NRI)



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References

PGI, 2012 - Assessment of shale gas and shale oil resources of the Lower Paleozoic Baltic-Podlasie-Lublin basin in Poland. First report.

Poprawa P., 2010 – Shale gas potential of the Lower Paleozoic complex in the Baltic and Lublin-Podlasie basins (Poland). Prz. Geol., 58:226-249.

Poprawa P., 2012 – The Impact of Shale Gas on the availability of feedstock – potential role of Europe. 3rd Annual Global Petrochemicals Technology Conferencem, Doha.

USGS, 2012 – Variability of Distribution of Well-Scale Estimated Ultimate Recovery for Continuous (Unconventional) Oil and Gas Resources in the United States. Open-File Report 2012-1118

