Gas in shales in European sedimentary basins

Data source: Poprawa, 2010
Poland – „unconventional” member of European Union with high potential of unconventional gas resources

Data source: Poprawa, Kiersnowski, 2010
Apart from Ordovician and Silurian shale resources, other shale horizons are considering as perspective


Data source: Poprawa, Kiersnowski, 2010
Ordovician and Silurian sedimentary basins in Poland with high potential of shale gas occurrences
Occurrence of dark shales in the Silurian of selected sections of the northern Poland (after Podhalańska, Modliński, 2006)

Huge shale thickness (in some cases over 3000 m), but only selected units has promising potential
Thickness of the Upper Ordovician shale increases from the east towards the west and north-west: in the Baltic Basin onshore from 3.5 m to 37 m and offshore from 26.5 m to 70 m (Modliński & Szymański, 1997), while in the Podlasie Depression and the basement of Płock-Warszawa Trough from 1.5 m to 52 m (Modliński & Szymański, 2008).

In the central part of the Baltic Basin for the individual wells the average TOC contents of this shale formation ranges from 1 % to 3 % (Poprawa, 2010b; Kowalski et al., 2010). In the western and central part of the Podlasie Depression the average TOC contents of the Upper Ordovician shale is equal to 1 % to 1.25 %, while in the basement of Płock-Warszawa Trough it ranges between 2.1 to 3.76 % TOC. In the Lublin region the average TOC of these sediments is lower than 1%. The average TOC contents of the Ashgill deposits usually is below 0.5 %, except of the Łeba Elevation where it reaches 4.5 %.

after P. POPRAWA
Thickness of the Llandovery sediments commonly ranges between 20-70 m, with a general tendency for the westwards increase (Modliński et al., 2006). The lower part of the Llandovery section on major part of the basin is characterized by high TOC contents (Klimuszko, 2002). The highest measured TOC contents reaches 20 %, while average TOC contents of the Llandovery shale usually equals to 1 % to 3% (Poprawa, 2010b).
Perspective areas of Lower Palaeozoic Dark Shales from the East European Craton in Poland

**Thickness of the Wenlock section** is significantly varies laterally from less than 100 m in the eastern part of the Podlasie Depression (SE) and Lublin region, to more than 1000 m in the western part of the Baltic Basin (NW).

Average TOC contents in a range of 1 % to 2 % are characteristic to the Wenlock sediments in the eastern Baltic Basin, as well as in a part of Podlasie Depression and Lublin region. In a remaining part of the discussed area average TOC contents of the Wenlock is less than 1 %.

**Wenlock lithofacies and thickness map** after P. POPRAWA
Burial depth of the Upper Ordovician and Lower Silurian shale increases in general from the east to the west. In the Polish part of the Baltic Basin the recent burial depth of these formations increases from approximately 1000 m in its eastern part to more than 4500 m in its western part. In the Podlasie Depression the recent depth to this formation also increases from the east, where it equals to approximately 5000 m, towards the west where near Warsaw reaches 4000 m. In the Lublin region lateral changes of burial depth to the Lower Paleozoic shale are more complex due to the presence of a system of faults with significant offsets limiting individual tectonic blocks. In this part of the Lublin region were the Lower Paleozoic section is reached and documented by boreholes depth to these sediments increases from some 1000 m in the eastern zones to 3000-3500 m in vicinity of the Kock fault zone.


Thermal maturity v. depth showing unconformity between Lower Paleozoic and Permo-Mesozoic complexes, indicate hydrocarbon generation from Silurian shales during Variscan burial stage (Carboniferous).

Thermal maturity v. depth showing lack of unconformity, indicate hydrocarbon generation from Silurian shale during Mesozoic time.
The acreage incorporated into assessment units and qualified into calculation of resources of shale gas (yellow color) and shale oil (green color) in a model with maximum thickness of shale intervals and with TOC contents > 2 % on the basis of 39 exploratory drillings in Poland from 1950-1990 years.

Data source: Grotek, Poprawa and Poprawa, 2012
An example of burial history and history of metamorphosis of organic matter from case well from East European Craton. This model assume hydrocarbons generation from Silurian shales during Mesozoic time.

after P. POPRAWA

Depression the average TOC contents of the Upper Ordovician shale is equal to 1 % to 1,25 %, while in the basement of Płock-Warszawa Trough it ranges between 2,1 to 3,76 % TOC. In the Lublin region the average TOC of these sediments is lower than 1 %. The average TOC contents of the Ashgill deposits usually is below 0,5 %, except of the Łeba Elevation where it reaches 4,5 %.

Data source: Poprawa, 2010
Compilation of geological, geochemical and geophysical data, characterizing shale gas/oil potential of the Lower Paleozoic shale interval in a given exemplary well from the Baltic Basin (Žarnowiec IG 1). TOCpd – measured present day TOC contents. TOCo – reconstructed original TOC contents. GR – gamma ray (increasing towards left-hand side). EN, EL – resistivity log (increasing towards right-hand side). NEGR – neutron log (increasing towards right-hand side)
High TOC differences within Lower Paleozoic deposits of East European Craton (N-E Poland).
Simplified cross-section across Baltic Basin (E-W) showing relatively simply tectonic framework, favourable for shale gas exploration and production (Witkowski, 1989).
AREA OF DISTRIBUTION OF LOWER PALEOZOIC SHALES IN POLAND

Red – best areas for accumulation of shale gas
Yellow – secondary areas

Licenses blocks for shale gas prospecting

June, 2012

Data source: Ministry of Environment
How great are unconventional gas resources of Poland?
No reliable estimate of the resources yet exists…

SHALE GAS RECOVERABLE RESOURCES

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

SHALE GAS

Shale gas recoverable resources of the onshore and offshore Baltic – Podlasie – Lublin Basin

Basin is estimated for maximum: **1920 Bcm (1,92 Tcm)**. Taking into account constraints on key parameters of the calculations the higher probability range of **recoverable shale gas resources** is: **346 - 768 Bcm**

Thank you