REGIONAL ASSESSMENT OF CBM POTENTIAL IN POLISH SILESIAN COAL BASIN

(GeoCapacity contribution)

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The (Upper) Silesian Coal Basin (SCB) is located mostly in southern Poland and continues into territory of Czech Republic, where its small part extends. Hard coal occurs here within formations of Upper Carboniferous (Namurian and Westphalian) and exploitation dates back since XVIII century. In Polish part coal (usually coking or steam) is mined in 39 collieries, which produce about 90 mln tonnes a year. Carboniferous is covered in south by Miocene and Carpathian flysch and in north either by Quarternary sediments, often quite thin, rarely by Triassic, or uncovered at all. In a dozen of collieries methane is exploited together with coal (depth range in both cases is usually 500-1000 m). CBM only is exploited in two sites in southern part of SCB (in one well and one shaft). ECBM-CO2 experiments have been carried out under RECOPOL and MOVECBM projects of EU 5th and 6th Framework Programme there.
Twenty three Coal/ CBM fields of PGI P > 1 Bcm in the Silesian Coal Basin were considered. They have estimated storage capacity of several Mt to several tens Mt each, but the most of these assessed CBM reserves are no deeper than 1 km. Total storage potential for the Polish part of SCB (up to 2 km) might reach a few Gtonnes. In southern part of the SCB, RECOPOL experimental ECBM site is located at Kaniów.
METHODOLOGY APPLIED IN CASTOR WP1.2

- known CBM reserves after PGI data (national geological survey)

- CBM reserve means CH4 content of over 4.5 m3/ t of coal

- coal/ CBM fields beyond current range of mining activities, of reserves above 1 Bcm PGI P, and covered by a good seal

- Storage Capacity = PGI P x ER x CO2density

- Exchange Ratio CO2:CH4 (ER) = 2; CO2density = 2 kg/ m3

- Storage capacity for selected 23 fields = 470 Mt

- Typical depth range is 500-1000 m (usually there is no reliable information on reserves below 1000 m, with minor exceptions).
INPUT: Digitised structural maps of tops and floors of four principal coal-bearing complexes of Upper Carboniferous (left - floor of Paralic series, the lowermost complex) after Geological Atlas of SCB, 2005 (PGI).

area size: 
~ 100 x 100 km
INPUT: Digitised structural maps of Upper Carboniferous formations

- Top of Carboniferous
- Floor of Cracow Ss. series
- Floor of Upper Silesian Ss. series
- Floor of Paralic series
- Floor of Mudstone. series
- Horizons superimposed
COAL BEARING CARBONIFEROUS OF (UPPER) SILESIAN COAL BASIN (after R. Osika, 1990):

<table>
<thead>
<tr>
<th>No.</th>
<th>Geological unit</th>
<th>Max. Coal thickness [m]</th>
<th>Coal seams [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cracow Ss. series</td>
<td>48</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Mudstone series</td>
<td>112</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Upper Silesian Ss. series</td>
<td>80</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Paralic series</td>
<td>99</td>
<td>2</td>
</tr>
</tbody>
</table>
INPUT: Coalbed Methane content at depth of 1500 m b.t.s., after Central Mining Institute, Katowice, PL, 2005
OUTPUT: Thickness maps of Upper Carboniferous complexes and for depth ranges; left - thickness of Upper Carboniferous formations covered by a good seal (see slide 3) in depth range 1-1.5 km.
OUTPUT: Estimations of gas in place per km² obtained for geometric-parametric model constructed on the base of INPUT data.
METHODOLOGY on calculating regional CO2 storage capacities:

- Calculating of volume of Upper Carboniferous formations at a certain depth range (e.g., 0.5-1; 1-1.5; 1.5-2 km; slide 6)

- Assuming a percentage of coal seams in these formations (after R. Osika, 1990; slide 7)

- Calculating coal seams' volume and mass (assuming density)

- Multiplying mass by a constant absorption capacity coefficient (after F. May, 2004 - GESTCO) and CO2 density we have adsorption potential

- Multiplying coal mass by averaged methane content (slide 8), replacement ratio (slightly variable with depth and/or coal rank) and CO2 density we have exchange potential - storage capacity
EXAMPLE on calculating regional storage capacities:

<table>
<thead>
<tr>
<th>Depth [m]</th>
<th>Volume [bln m³]</th>
<th>Coal seams [%]</th>
<th>Coal volume</th>
<th>Coal density</th>
<th>Coal mass [Gt]</th>
<th>Adsorption capacity of CO₂ [m³/t]</th>
<th>CO₂ density [t/m³]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000-1500</td>
<td>1419.078</td>
<td>variable</td>
<td>58.4</td>
<td>1.3</td>
<td>75.92</td>
<td>33</td>
<td>0.002</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth [m]</th>
<th>Coal mass [Gt]</th>
<th>Adsorption potential of CO₂ [Mt]</th>
<th>CH₄ content [m³/t]</th>
<th>CH₄ resources [bln m³]</th>
<th>Replacement ratio</th>
<th>CO₂ density [t/m³]</th>
<th>Exchange potential of CO₂ [Mt]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000-1500</td>
<td>75.92</td>
<td>5011</td>
<td>variable</td>
<td>424</td>
<td>2.5</td>
<td>0.002</td>
<td>2120</td>
</tr>
</tbody>
</table>

Storage capacity estimated for the depth range is 2120 Mt; for depth range 1500-2000 m, the storage capacity is 1914 Mt.

According to results of RECPOL project there are more favourable conditions for ECBM at a depth range below 1000 m (preferably 1000-1500 m) than at depth range 500-1000 m, where CBM resources are relatively well known and assessed, but more or less affected by ongoing mining activities. Conditions at depth range 1500-2000 m are less known.
- In CASTOR WP1.2 (for Poland) figures on CO2 storage capacities in coal/CBM fields, based on known CBM reserves, referred mostly to depth range of 500-1000 m.

- Estimations of a regional storage capacity (the whole area of Polish part of the Silesian Coal Basin) for deeper coal seams give value of one order of magnitude bigger (about 4 Gtonnes).

- According to RECOPOL results (CMI) the most favourable conditions for ECBM might be at a depth range of 1000-1500 m (but this does not exclude CBM resources appearing in other depth ranges - coal rank and dynamic reservoir properties matter).
I would like to thank prof. Paweł KRZYSTOLIK of Central Mining Institute, Mikołów/Katowice, and his co-workers, for information on outcome of RECOPOL project and for information on methane content in deep coal seams of Silesian Coal Basin.