Geological Model of Early Sarmatian Horizons of the Underground Gas Storage Tvrdonice (Vienna Basin)

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Investigated area

Vienna Basin

Hrušky field
UGS Tvrdonice

Wien
Bratislava

RWE Transgas Net
UGS Tvrdonice facts:

• Depleted oil and gas field in the part of Vienna Basin named Central Moravian Depression

• Normal faulted, structural and lithological traps

• UGS started operation in the year 1971

• 3 storage sand horizons - 8th Sarmatian, 12th-14th Sarmatian and 9th Upper Badenian

• In the area of storage permit (4.9 km²) there are more than 63 operation and control wells

• 1 horizon in testing - 9th-11th Sarmatian
## Lithology and Stratigraphy in the Central Moravian Depression of Vienna Basin

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<th>lithology</th>
<th>horizons</th>
<th>formations</th>
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<td>5.6</td>
<td>pliocene pontian 180</td>
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<td>valtice mb.</td>
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<td>11.5</td>
<td>pannonian 650</td>
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<td>sarmatian 700</td>
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<td>bilovice fm.</td>
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<td>14.4</td>
<td>upper badenian 600</td>
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<td>15.7</td>
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<td>lower lužice fm.</td>
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- **Lignite**: black
- **Limestone**: light blue
- **Variegated Clay**: medium blue
- **Calc. Clay**: green
- **Sand, Sandstone**: yellow
- **Conglomerate**: red

*Legend for lithology*
Input data for interpretation

- 237 wells (data of different quality) – drilled from the time of primary production (during World War II) to the present.
- 3D seismic survey (20 km²) acquisition in the year 2002
- 4 check shots in the investigated area
Seismic Cross-Section and Main Structural Features

- Lanzhot-Hrusky main fault
- Floodplain
- Channels

Sections:
- 8th S
- 9-11th S
- 12-14th S
Timeslice (-1251 ms) at the Base of the 12th-14th Sarmatian Sand

2 generations of channels, younger eroded older channel and adjacent floodplains

For early Sarmatian horizons, structure forming of the main fault running continuously since Sarmatian up to Pannonian, probably to present days
Creating a 3D reservoir structural model based on 3D seismic interpretation and well data

Acoustic impedance sampling from an attribute cube into a 3D grid

Facies interpretation from well logs

Facies modeling

Calculating petrophysical properties from well logs

3D property model of porosity and permeability based on AI and facies
Workflow

Creating a 3D reservoir structural model based on 3D seismic interpretation and well data

Interpretation of faults has brought these results:

- specification of position of the main fault
- existence of branched minor faults caused open fault blocks to the lower part of the structure.
**Workflow**

Creating a 3D reservoir structural model based on 3D seismic interpretation and well data

Interpretation tops and bases of early Sarmatian horizons including the 9th-11th and the 12th-14th sandy complexes.

It was difficult to interpret no consistent internal surfaces in the channel systems, so this problem was solved in the next step.
Relative acoustic impedance sampling from an attribute cube into a 3 grid.

It can be used for:

- 3D trend data for the pixel based method
- collocated co-kriging as a second variable during 3D propagating of porosity.
Workflow

Recognized fluvial facies from well logs

channels and channel margins

levees

crevasses

floodplains
Facies model of the 9th-11th Sarmatian sandy complex.

- Channels have lower sinuosity and drift than channels in the 12th-14th Sarmatian.
- Channels are split on the flanks of the older floodplain in the middle part of the reservoir.
Calculating petrophysical properties from well logs
Correlation porosity and permeability for fluvial facies in the 12th-14th Sarmatian sandy komplex levee
Correlation porosity and permeability for fluvial facies in the 12th-14th Sarmatian sandy complex
Main output: 3D property model of porosity and permeability based on AI and facies

9 -11th Sarmatian Base
12th-14th Sarmatian - Base

Amplitude map

Porosity map
Conclusions

- New fault interpretation defined structural framework for studied reservoirs.
- Existence of fluvial channel systems caused strong vertical and lateral variability of petrophysical properties in reservoirs of early Sarmatian horizons.
- Channels, facies with the best porosity and permeability determine priority migration for fluids.
- Horizon interpretation described morphology of complexes and closed contour for secure structure operating.
- 3D porosity model has brought specification of volume calculation.
- Geological model with incorporated fluvial facies minimizes risk with introducing new production wells to reservoir.