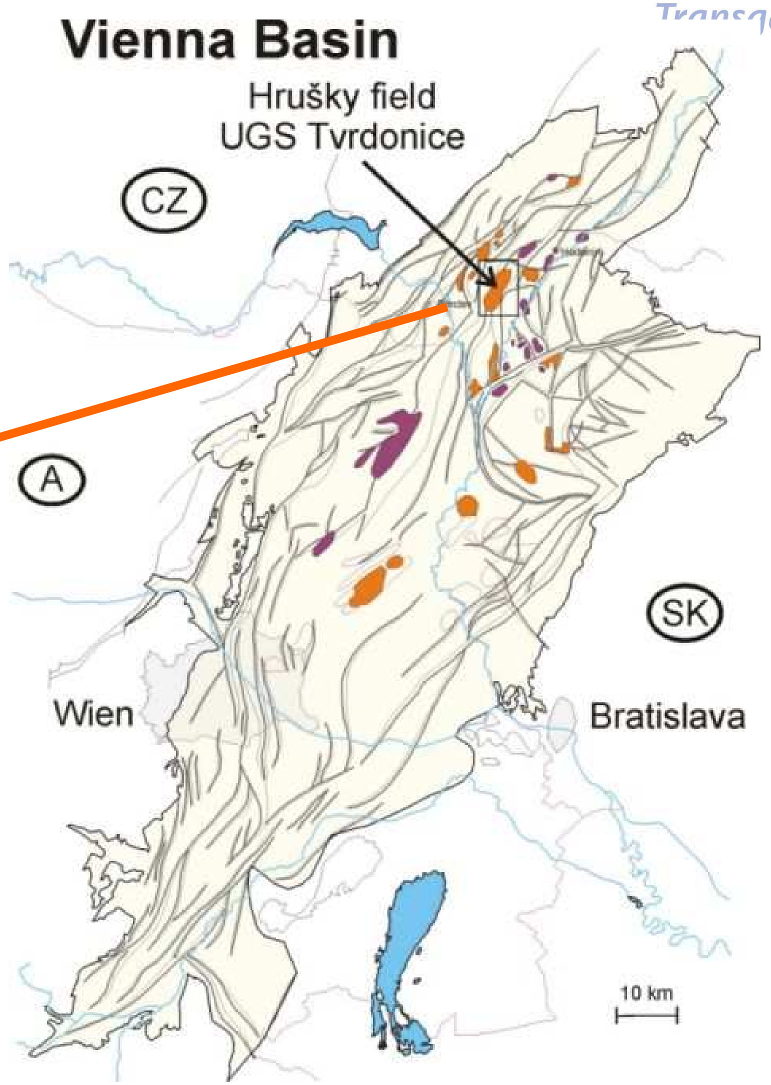
Geological Model of Early Sarmatian Horizons of the Underground Gas Storage Tvrdonice (Vienna Basin)

Lukáš Kopal, Kateřina Helešicová, Pavel Čížek

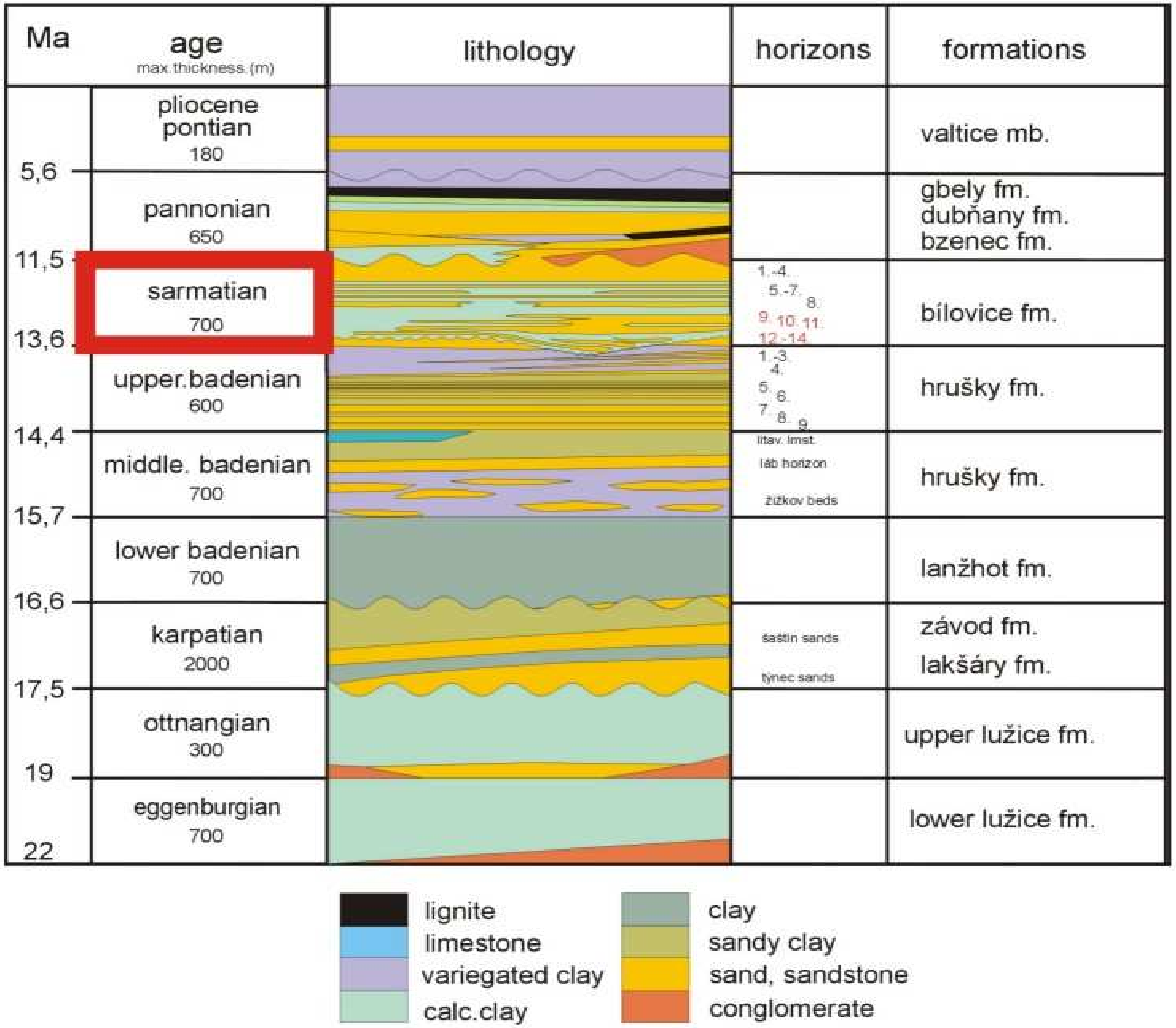
Investigated area



UGS Tvrdonice facts:

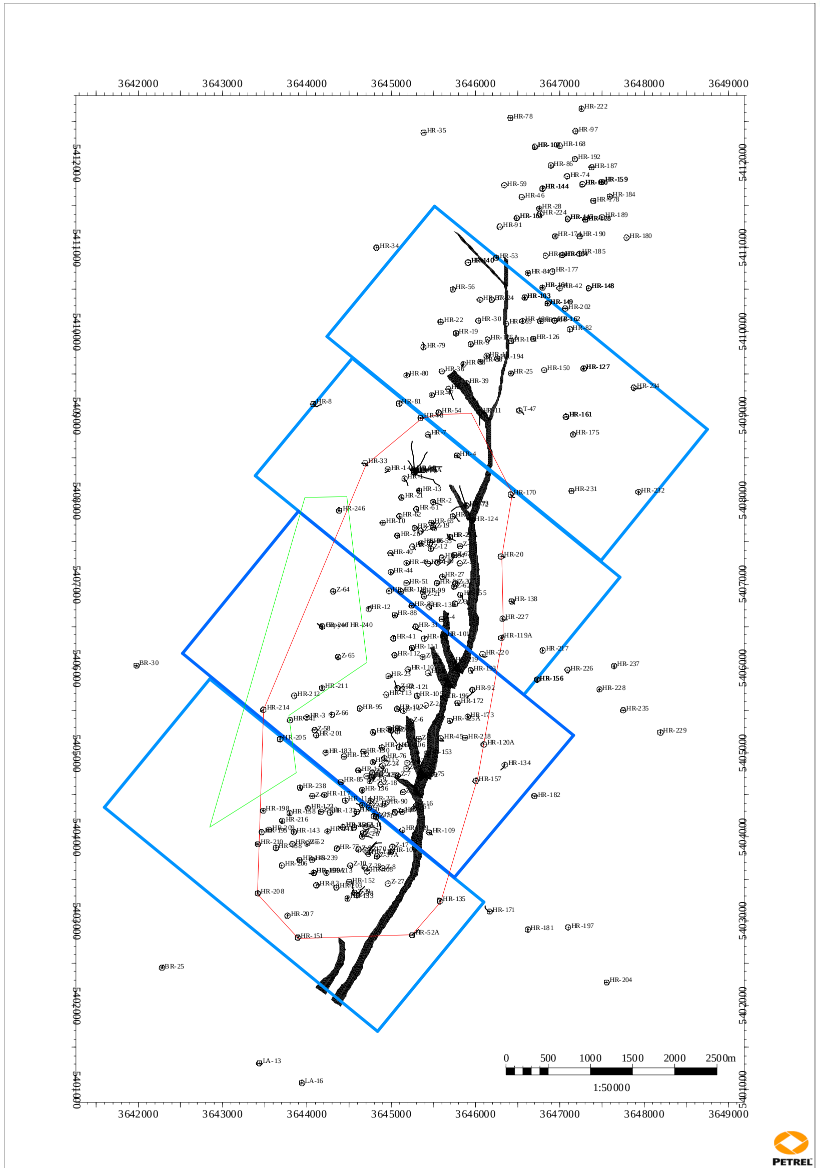
- Depleted oil and gas field in the part of Vienna Basin named Central Moravian Depression
- Normal faulted, structural and lithological traps
- UGS started operation in the year 1971
- 3 storage sand horizons - 8th Sarmatian, 12th-14th Sarmatian and 9th Upper Badenian
- In the area of storage permit (4.9 km^2) 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

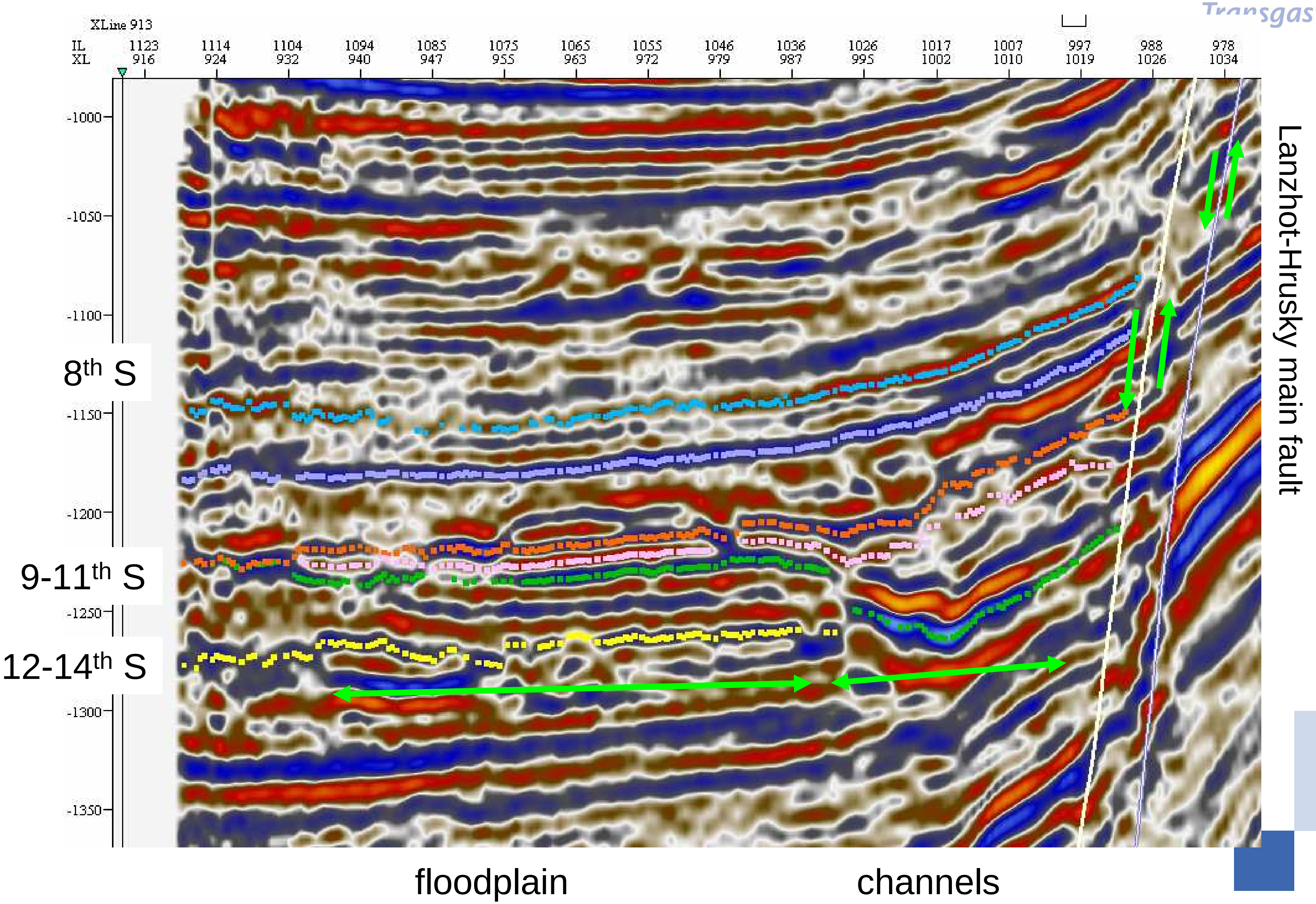


Input data for interpretation

- 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

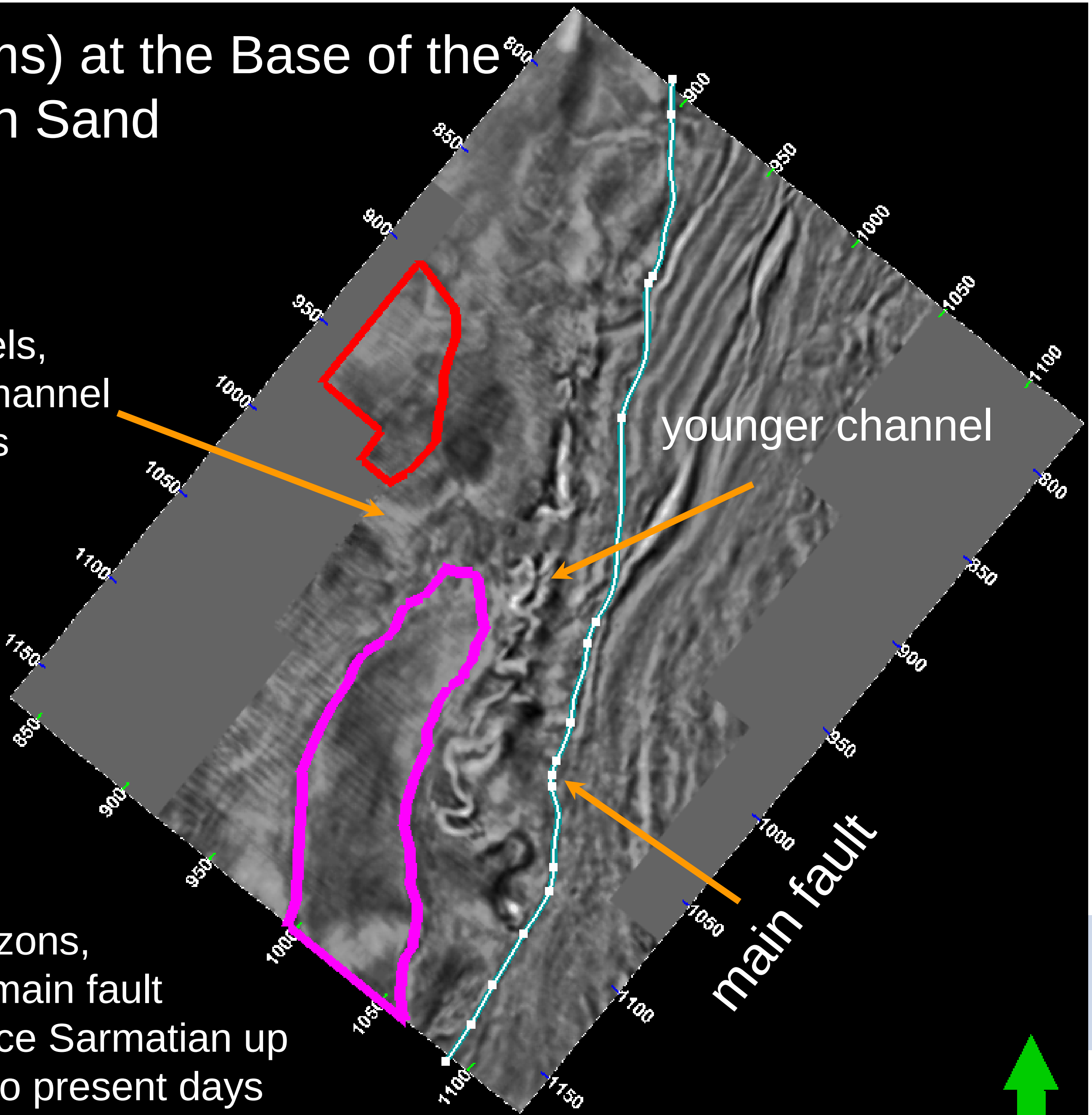


Seismic Cross-Section and Main Structural Features



Timeslice (-1251 ms) at the Base of the 12th-14th Sarmatian Sand

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



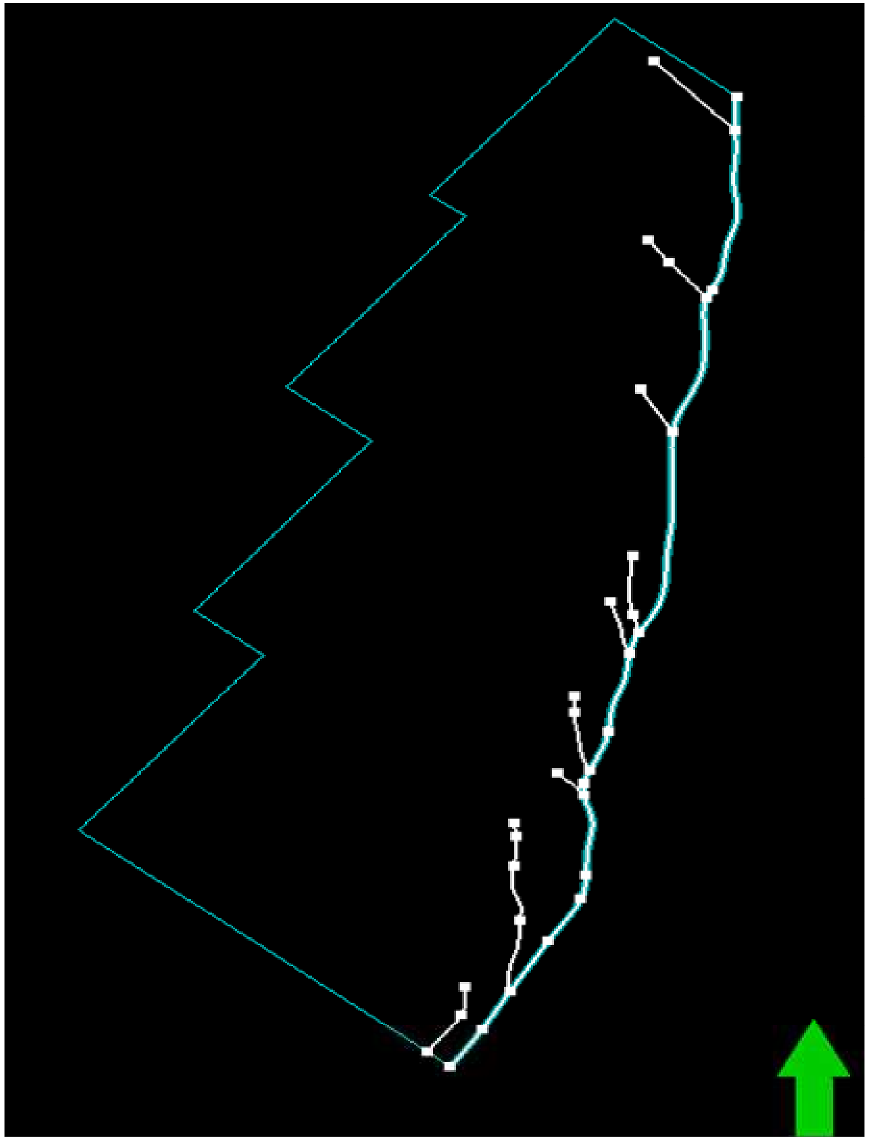
For early Sarmatian horizons,
structure forming of the main fault
running continuously since Sarmatian up
to Pannonian, probably to present days

Workflow

- 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:

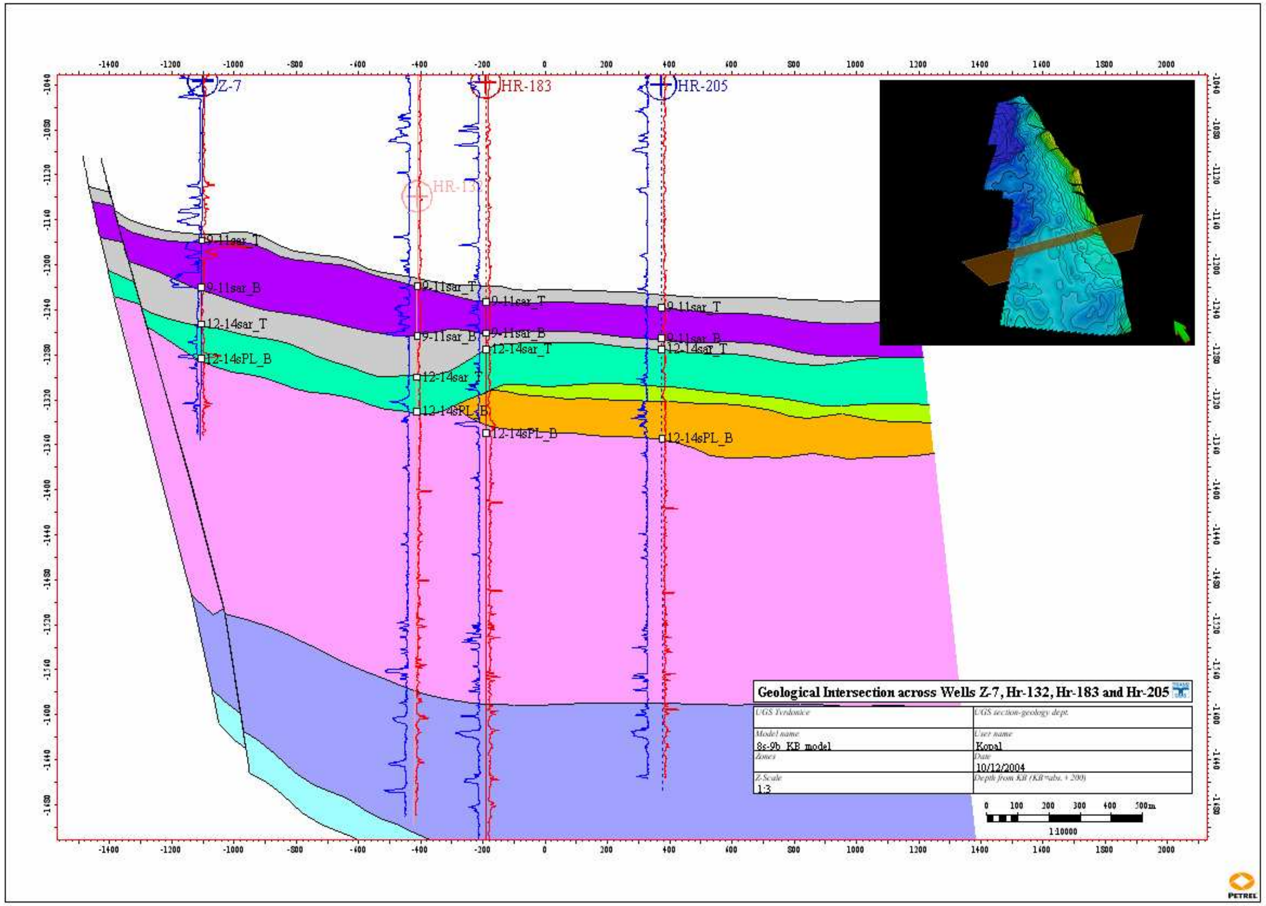
- specification of position of the main fault

- 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.

Workflow

RWE Transgas Net

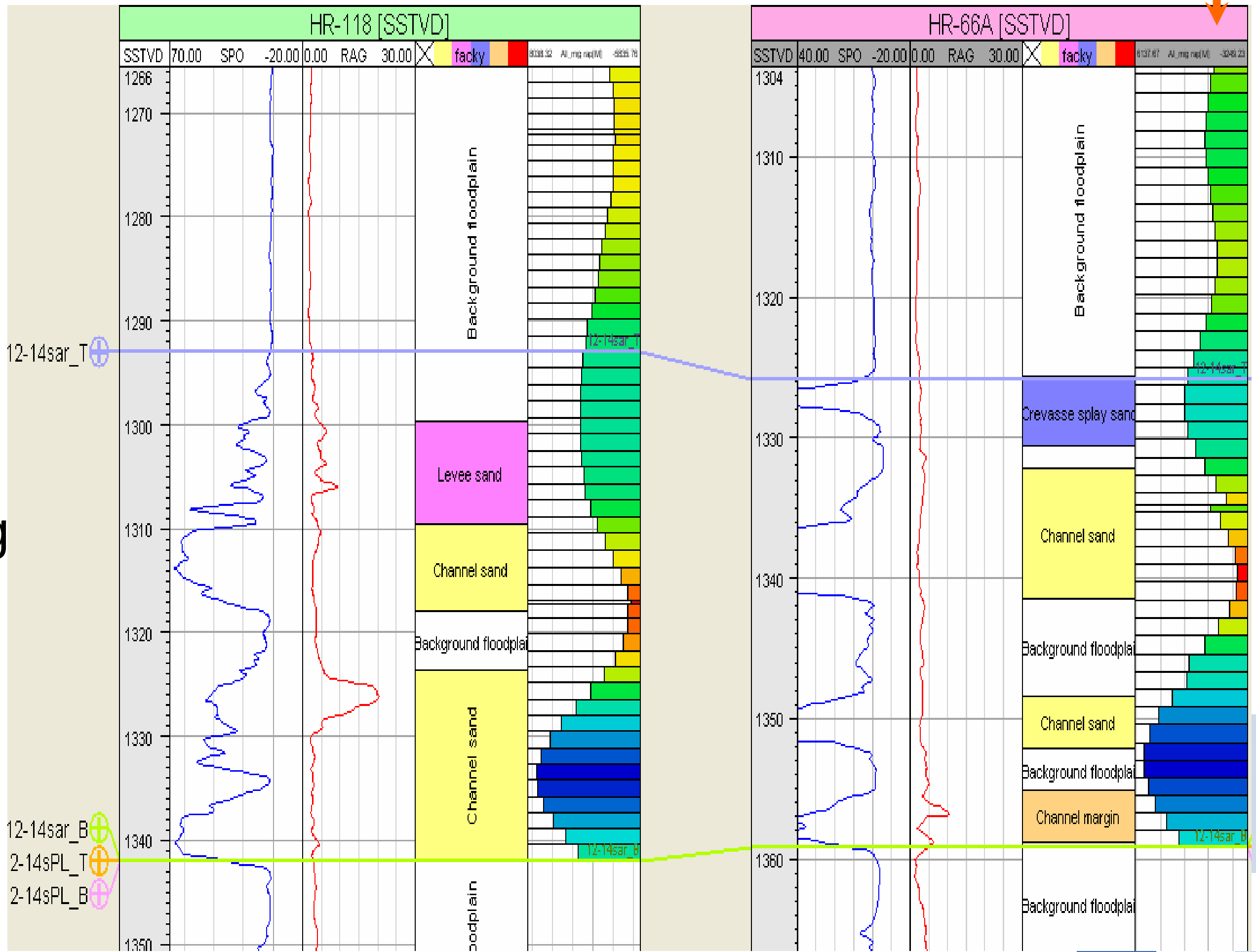
How to capture channels in the early Sarmatian horizons which caused internal lithological changes?

AI

Relative acoustic impedance sampling from an attribute cube into a 3 grid.

It can be used for:

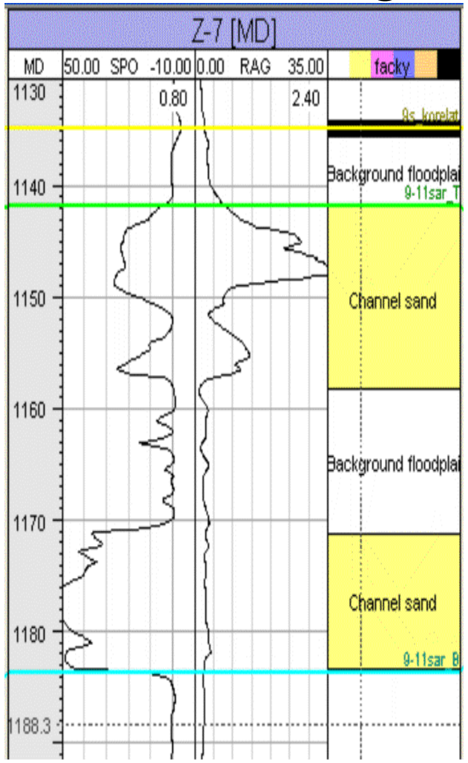
- 3D trend data for the pixel based method
- collocated co-kriging as a second variable during 3D propagating of porosity.



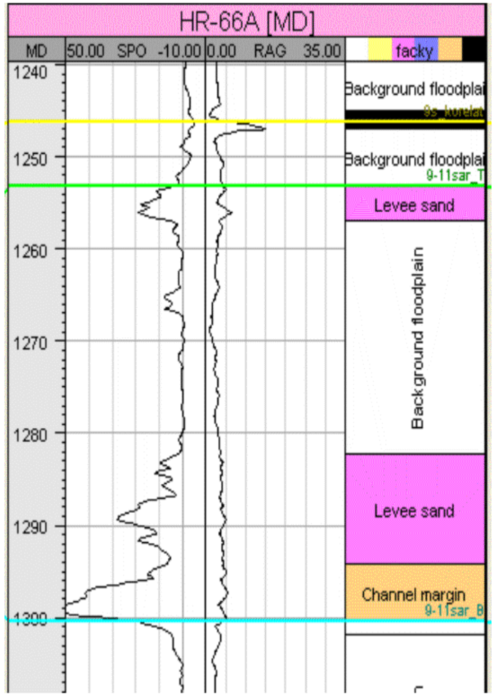
Workflow

Recognized fluvial facies from well logs

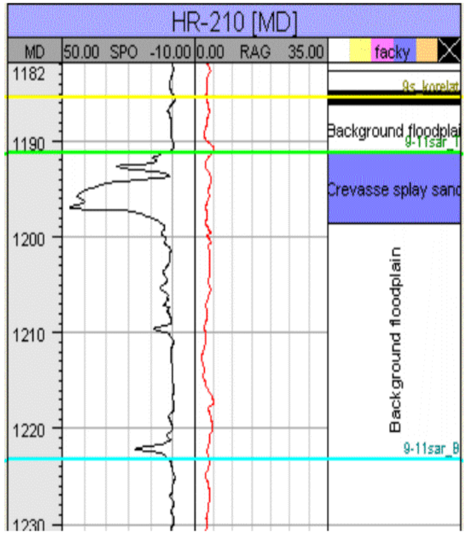
channels and
channel margins



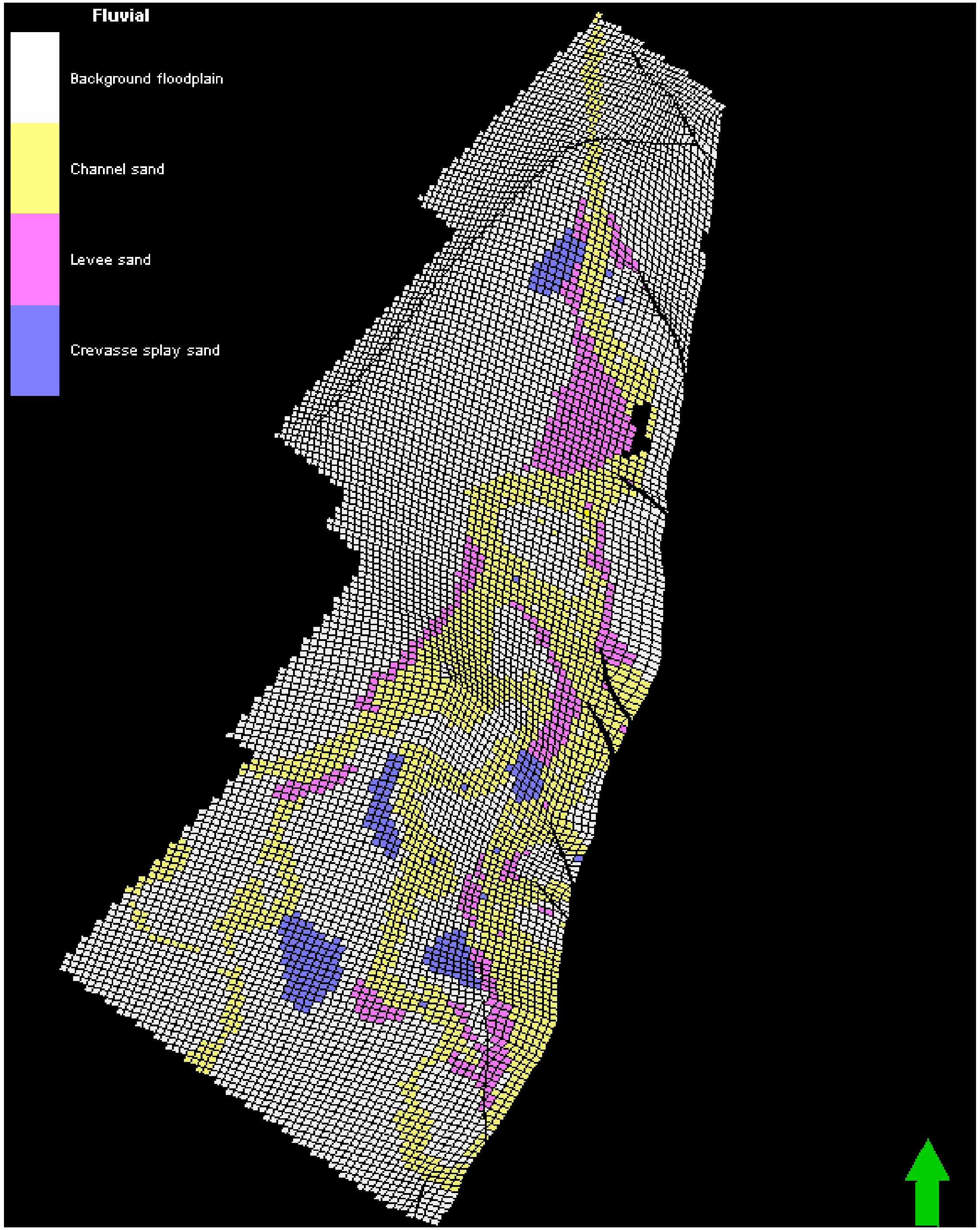
levees



crevasses



floodplains



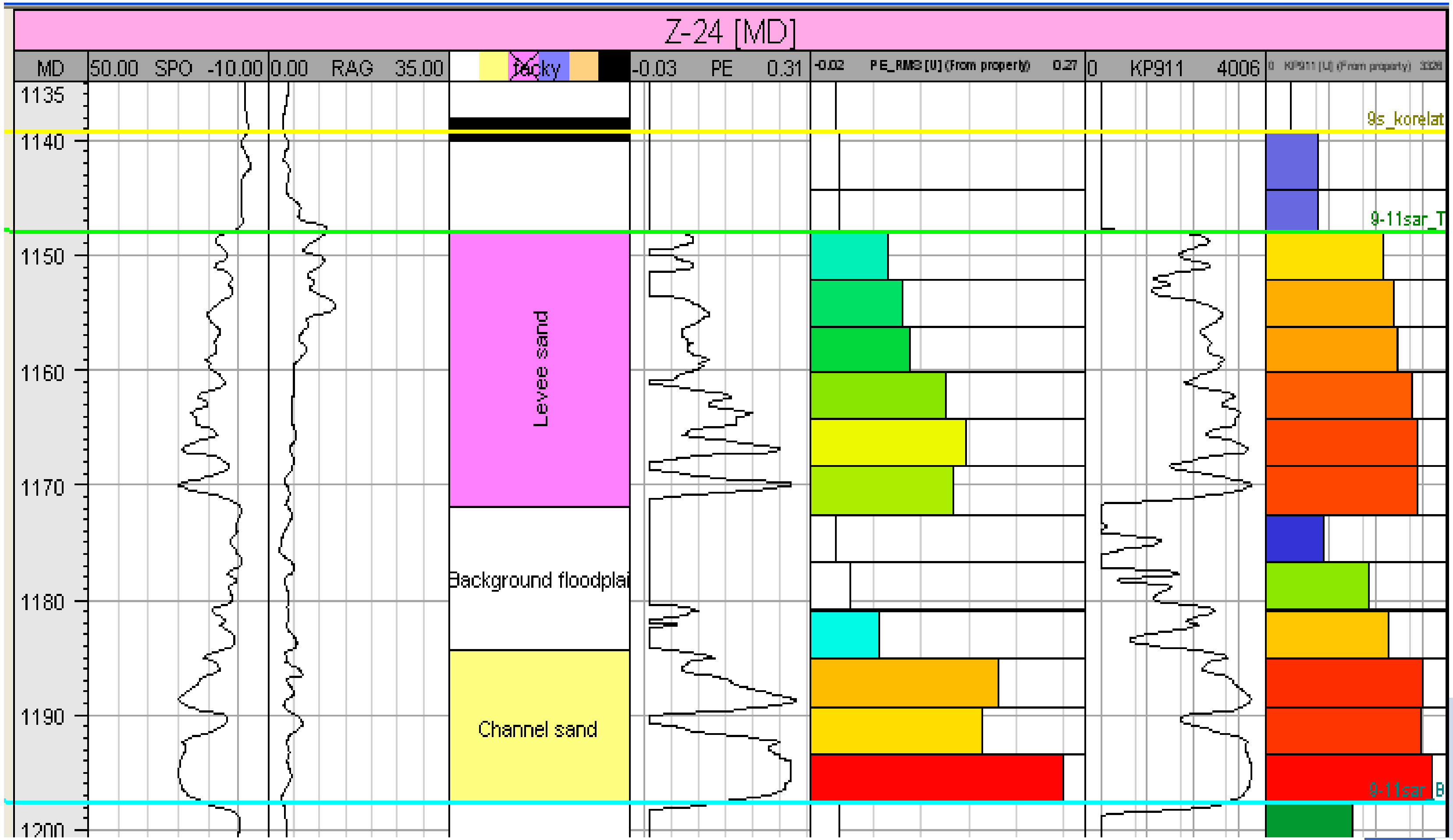
Workflow

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

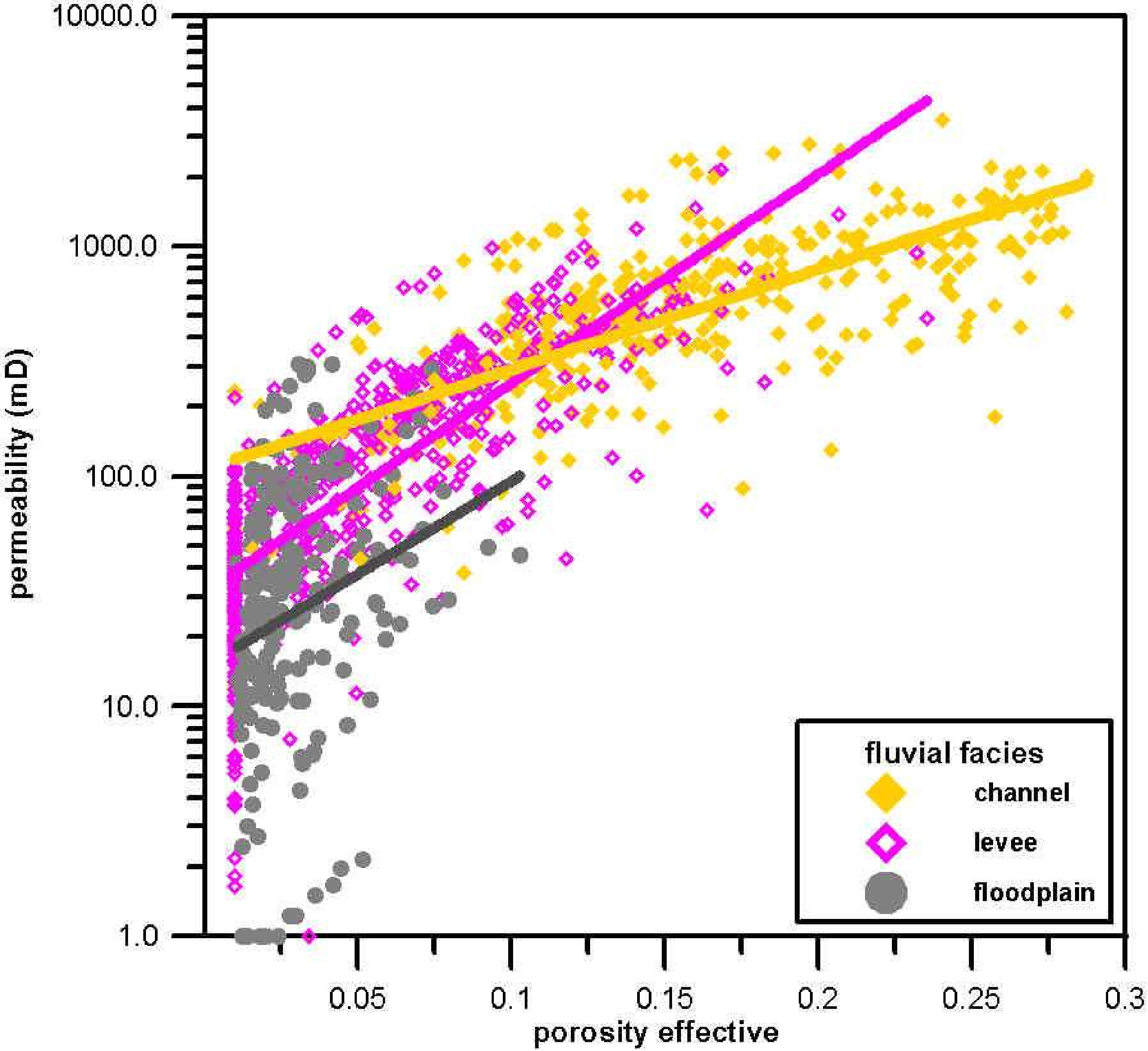
- Channels have lower sinuosity and drift than channels in the 12th-14th Sarmatian.
- Channels are splitted on the flanks of the older floodplain in the middle part of reservoir

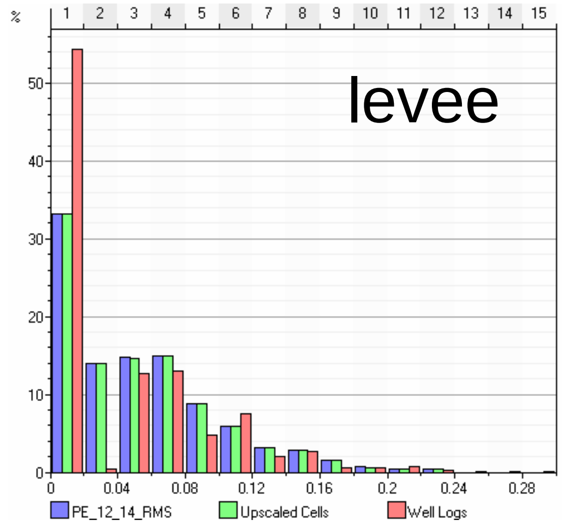
Workflow

Calculating petrophysical properties from well logs

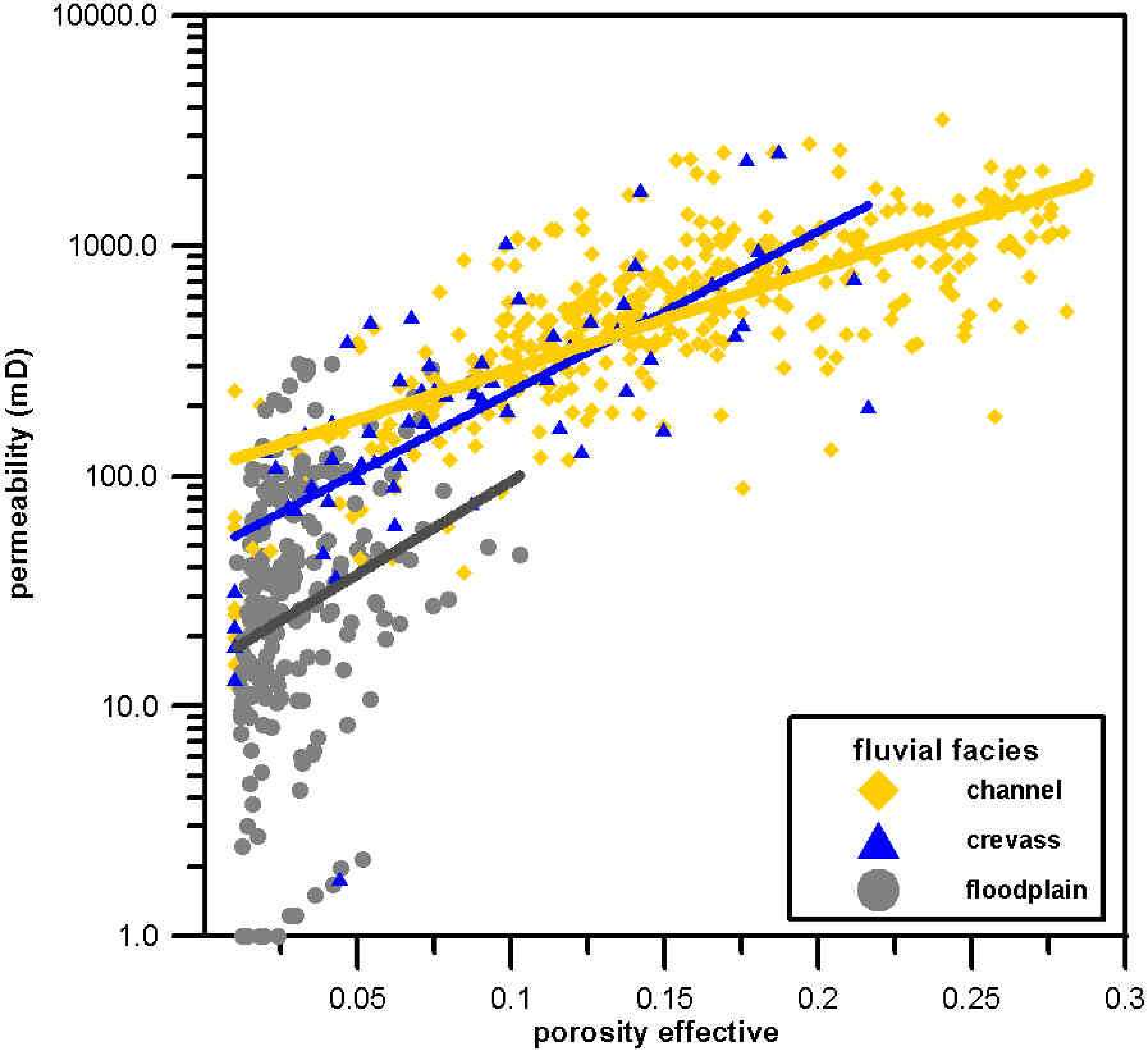


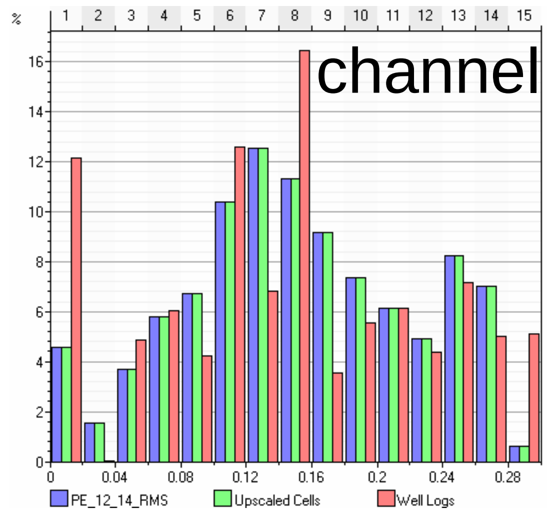
Correlation porosity and permeability for fluvial facies in the 12th-14th Sarmatian sandy komplex





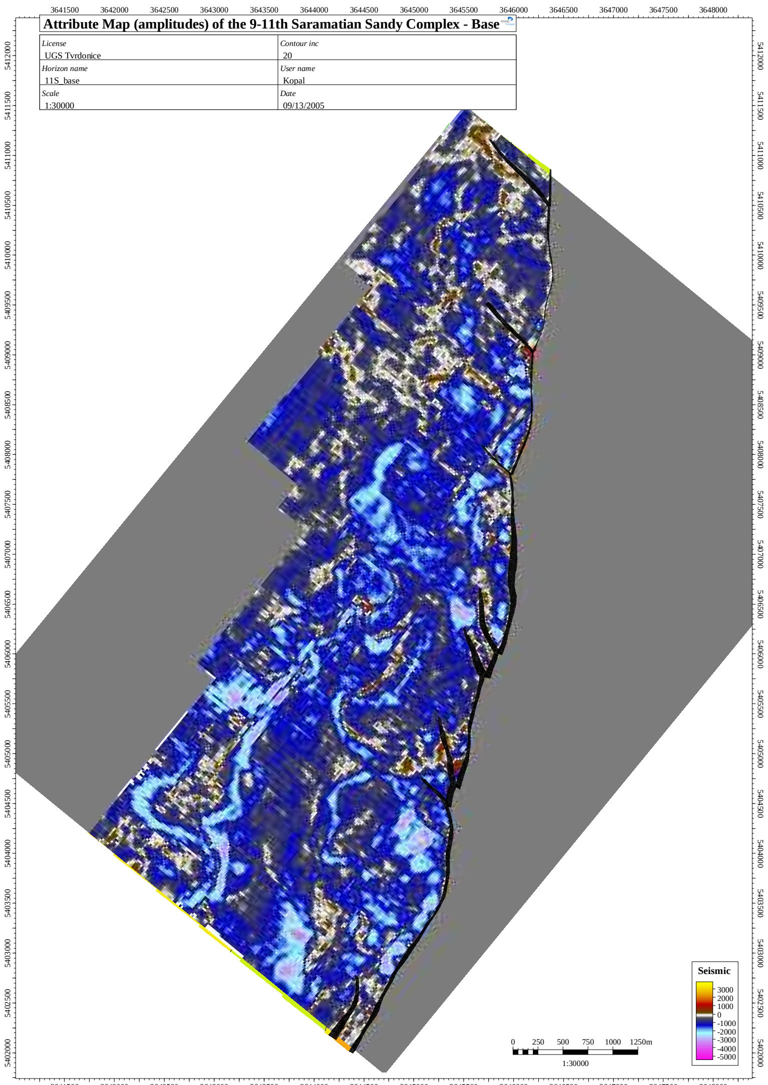
Correlation porosity and permeability for fluvial facies in the 12th-14th Sarmatian sandy complex



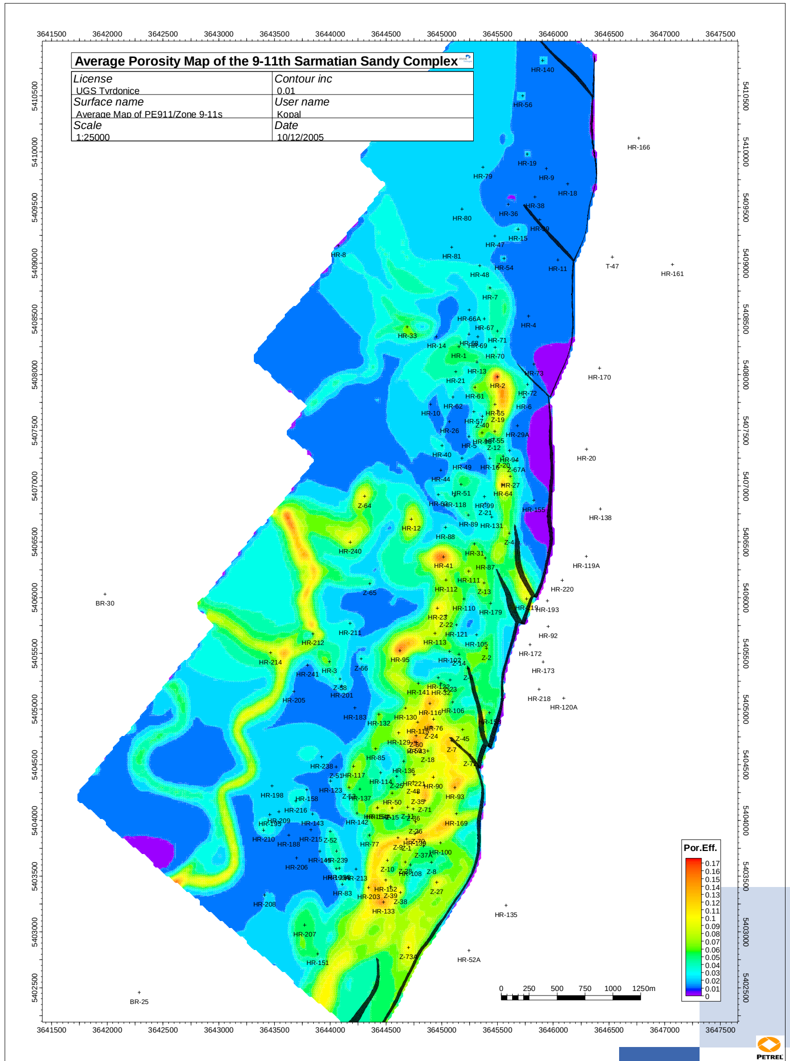


Main output: 3D property model of porosity and permeability based on AI and facies

9 -11th Sarmatian Base



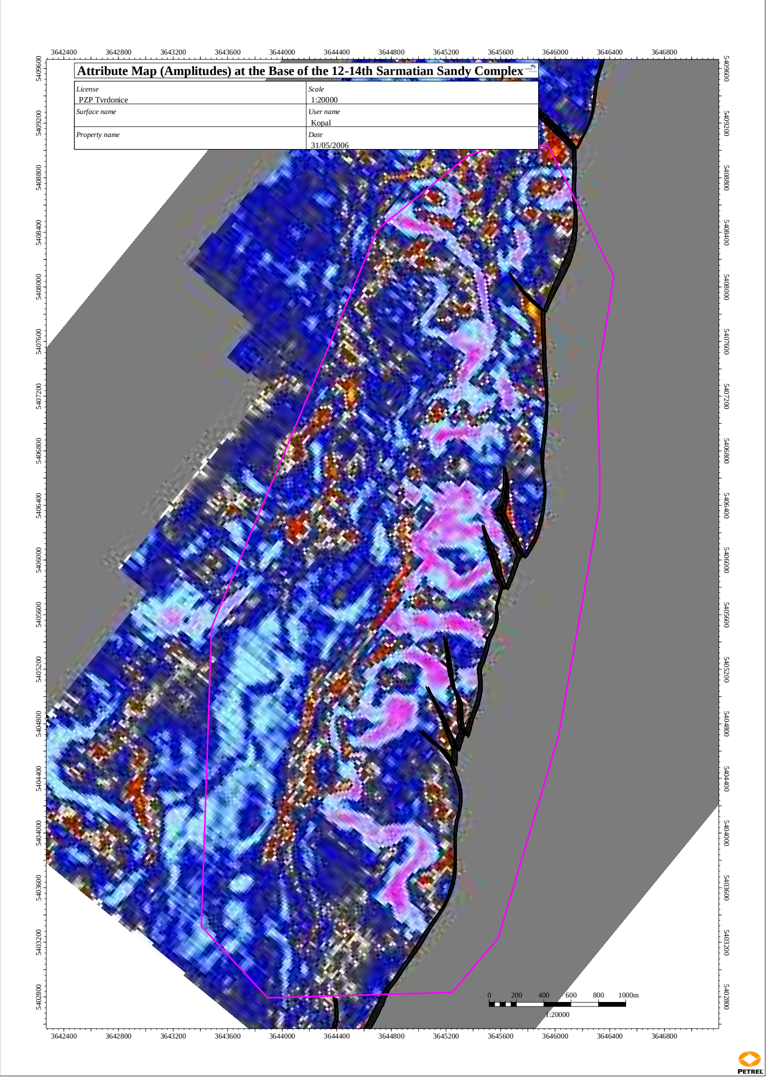
Amplitude map



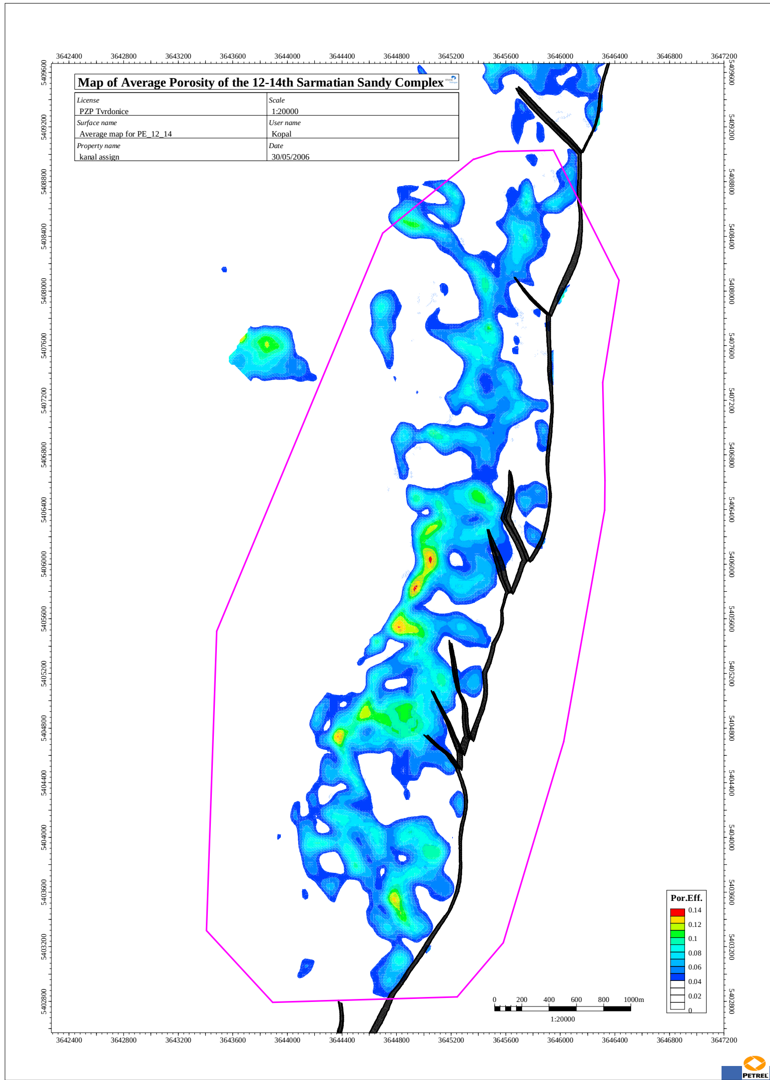
Porosity map

12th-14th Sarmatian - Base

RWE Transgas Net



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.