Geological Re-Evaluation of the Mature Reservoirs of the Hochleiten-Pirawarth Fields (Vienna Basin)*

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Abstract

The Hochleiten-Pirawarth fields are located in the Vienna Basin, Austria, approximately 30 km to the northeast of Vienna. The comprehensive modelling and re-evaluation effort focused on sediments deposited in near-shore environments in the Middle to Late Miocene. The Vienna Basin formed a part of the Central Paratethys at this time. The deposition was defined by the transgressive-regressive cycles resulting in a mixed layer-cake to jigsaw-type reservoir architecture. The regional NE-SW oriented structural feature of the Steinberg Fault system and its multiple hanging wall splays generate the highly compartmentalized Hochleiten-Pirawarth fields.

The Hochleiten Field started production in 1977; 75 wells were drilled with production from 11 reservoirs. Cumulative production is 2.74 million tons of oil and 283 million Nm^3 of gas (Nov. 2018). The Pirawarth Field started production in 1958; 115 wells were drilled with production from 13 reservoirs. Cumulative production is 2.92 million tons of oil and 485 million Nm^3 of gas (Nov. 2018).

Due to the long life of both fields and differing views on their remaining potential, an integrated study was initiated at the end of 2015. The aim was to achieve a holistic view of both fields and to increase the chance of success of future wells.

To reduce geological uncertainty in the highly compartmentalized area, a field-scale depth processing was performed on a merged seismic dataset covering both fields. The established multi-layer velocity model greatly increased confidence in the structural picture. Based on this approach a comprehensive structural model was created for a large spatial area, vertically covering the Neogene reservoirs. For the geomodel a larger areal extent was also chosen to minimize possible boundary effects. To enhance overall quality a complete petrophysical re-evaluation of available log data for all Hochleiten and selected Pirawarth wells was carried out. The then-generated property model utilizes a net to gross approach that creates a net log using global porosity and Vshale cutoffs, while variogram analysis was carried out for each single reservoir horizon separately.

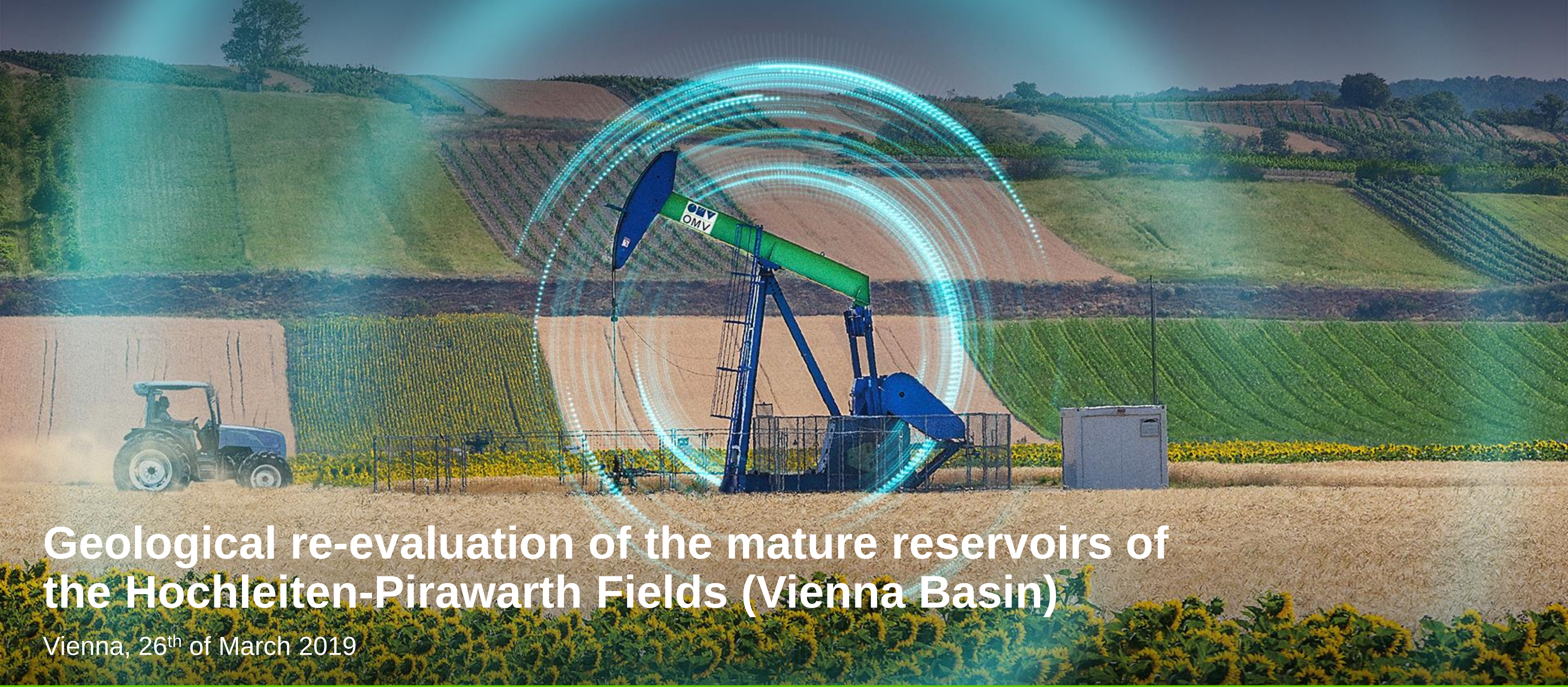
For future well planning efforts supported by the geomodel, the estimation of hydrocarbon volumes in place had a very high priority. To achieve robust results, different volume calculation methods were applied to determine the recoverable hydrocarbon volumes initially in place (STOIIP, GIIP): (1) A stochastic Monte-Carlo approach, (2) the static model, and (3) several applied reservoir engineering methods. The results of all volume calculations were reviewed and agreed by an interdisciplinary team.

The presented Hochleiten-Pirawarth geomodel is the first holistic modelling effort integrating both fields. Finalized in October 2018, the study yielded a realistic view of the complex reservoir geology, revised volumes and new ideas for future wells.

References Cited

Kreutzer, N., 1993, Das Neogen des Wiener Beckens [The Neogene of the Vienna Basin], *in* F. Brix and O. Schultz, (eds), Erdöl und Erdgas in Österreich, Naturhistorischen Museum, Wien und F. Berger, Horn, Austria.

Kreutzer, N., 1986, Die Ablagerungssequenzen der miozanen Badener Serie im Feld Matzen und im zentralen Wiener Becken: Erdol-Erdgas-Kohle, v. 102, p. 492-503.



Geological re-evaluation of the mature reservoirs of the Hochleiten-Pirawarth Fields (Vienna Basin)

Vienna, 26th of March 2019

Outline - why was this study carried out?

- Production of oil and gas since 1958.
- Currently 59 active wells in Hochleiten and 41 active wells in Pirawarth.
- Structurally complex field, documentation only by maps and cross sections until 2015.

The purpose of the presented study was to gain a holistic view of a mature field.

- **New opportunities (infill wells, reperforation and exact volume estimations) to improve recovery and prolong the production.**

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Location map

The Hochleiten-Pirawarth Fields are located in the central Vienna Basin.

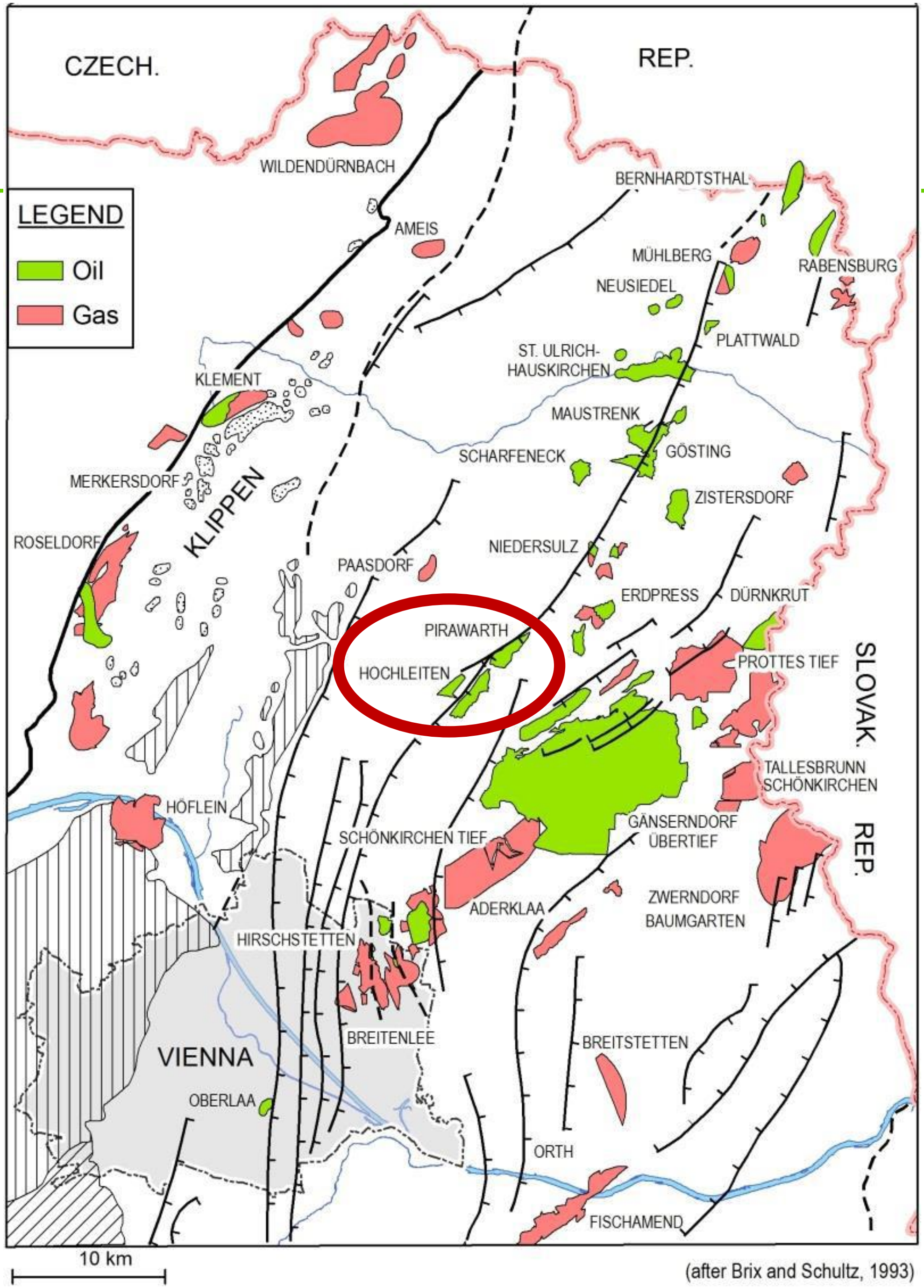
The main regional feature is the Steinberg Fault System

- Active through almost all evolution phases of the Vienna Basin
- Badenian to Pannonian sections display significant thickness differences on both sides of the fault system indicating syntectonic deposition

Extensional tectonic activity during Neogene separated the area into two main blocks:

- Footwall block (Mistelbach High)
- Hangingwall block – separation into several compartments
- Main reservoirs are located in the Sarmatian and Badenian

Both fields consist of highly compartmentalized, stacked reservoirs.



(after Brix and Schultz, 1993)

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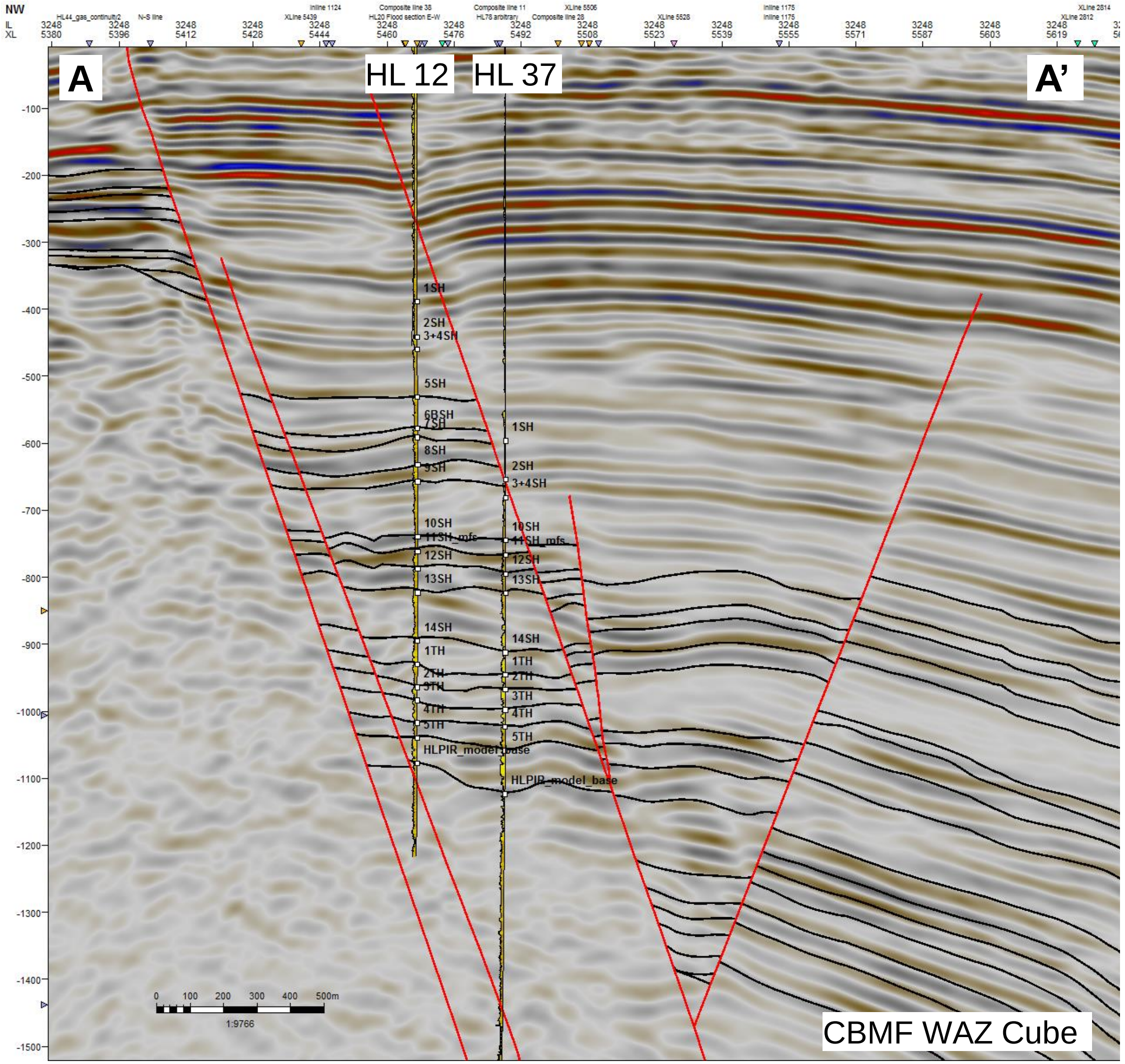
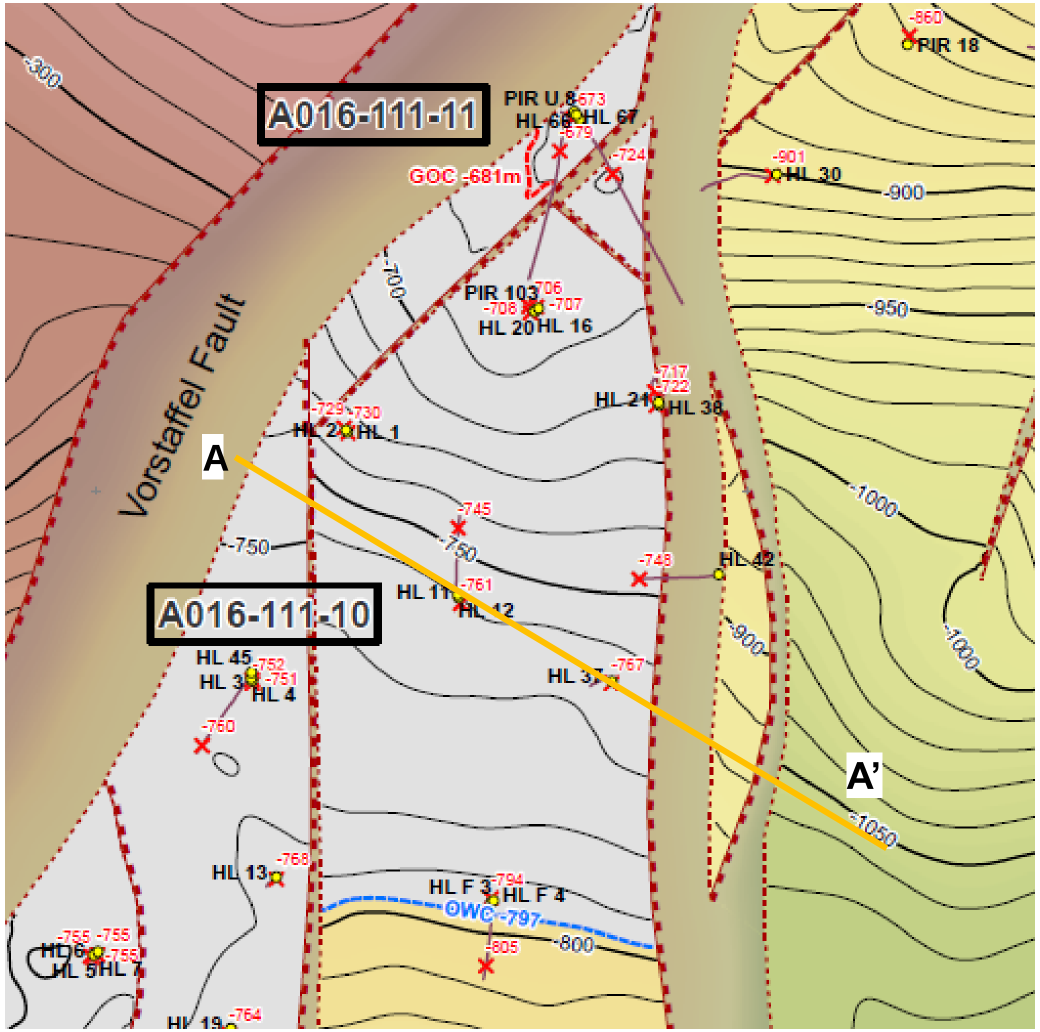
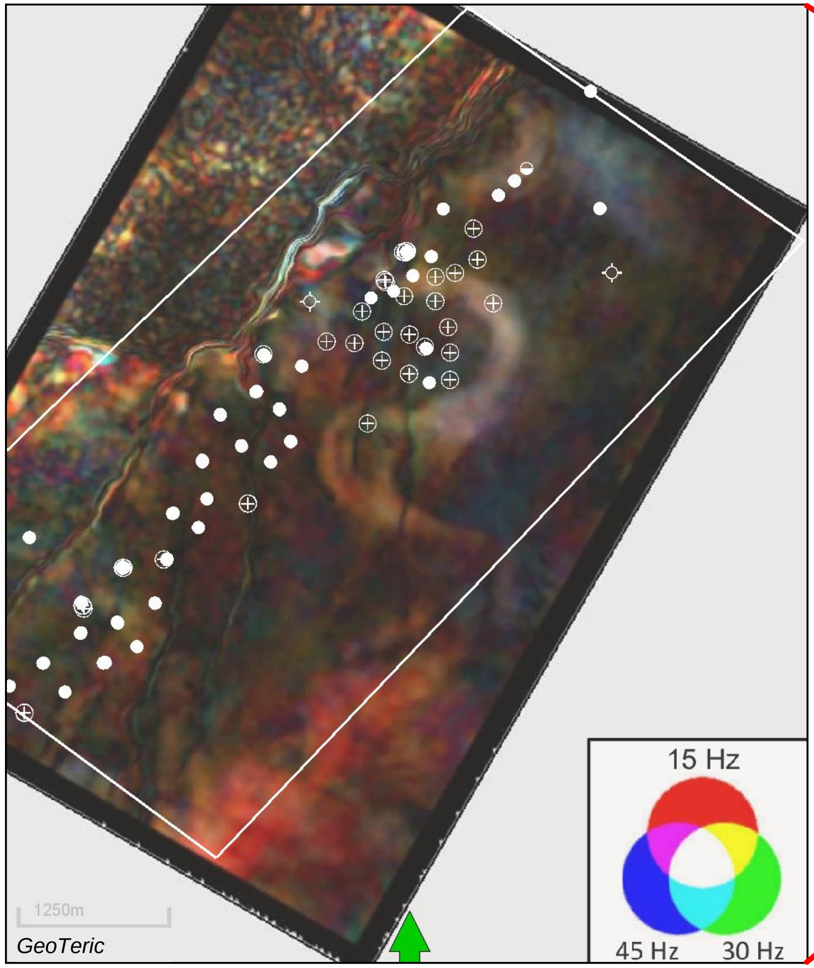
Seismic cross section

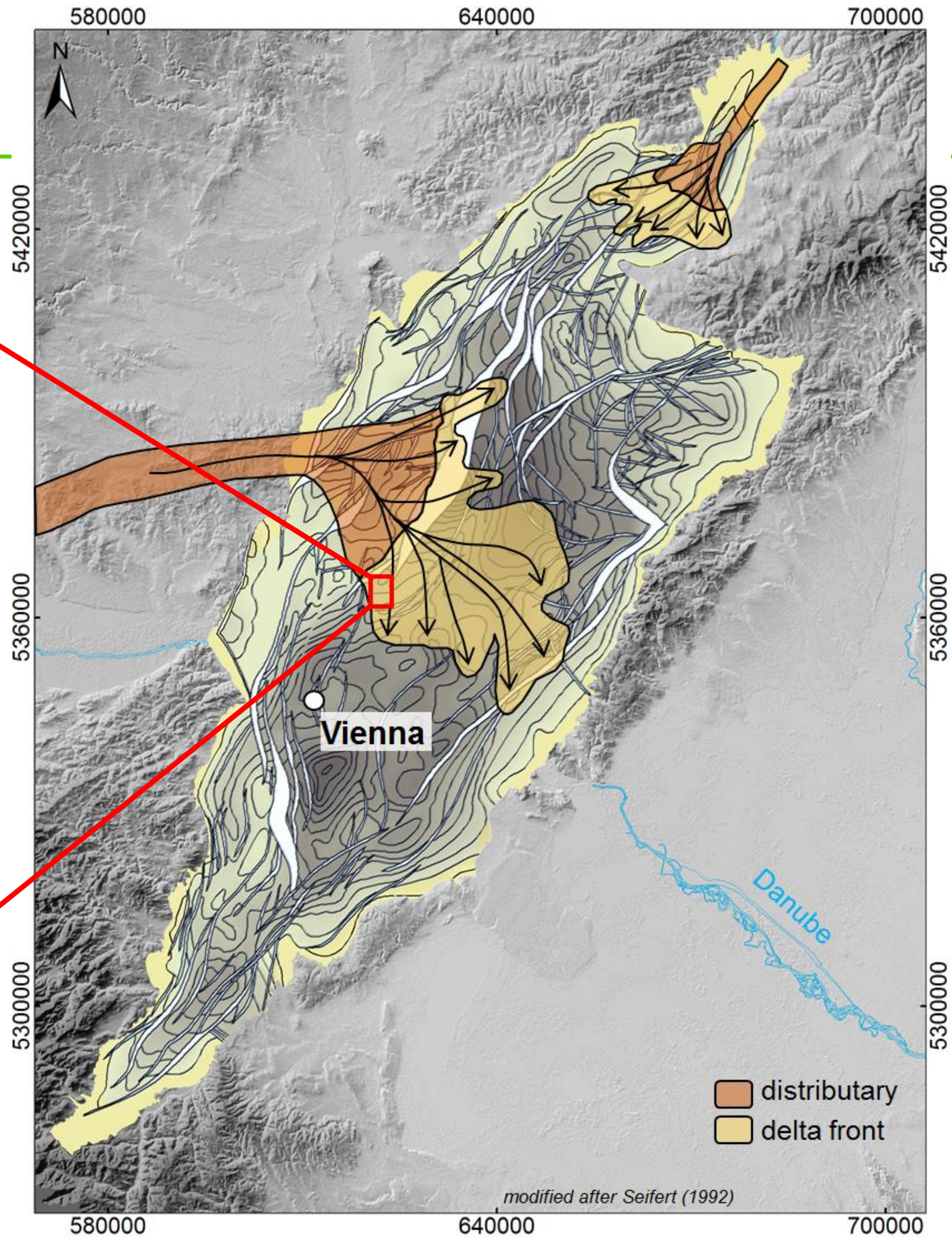




Seismic attribute study



HD frequency decomposition revealing Late Sarmatian infill of the Vienna Basin.



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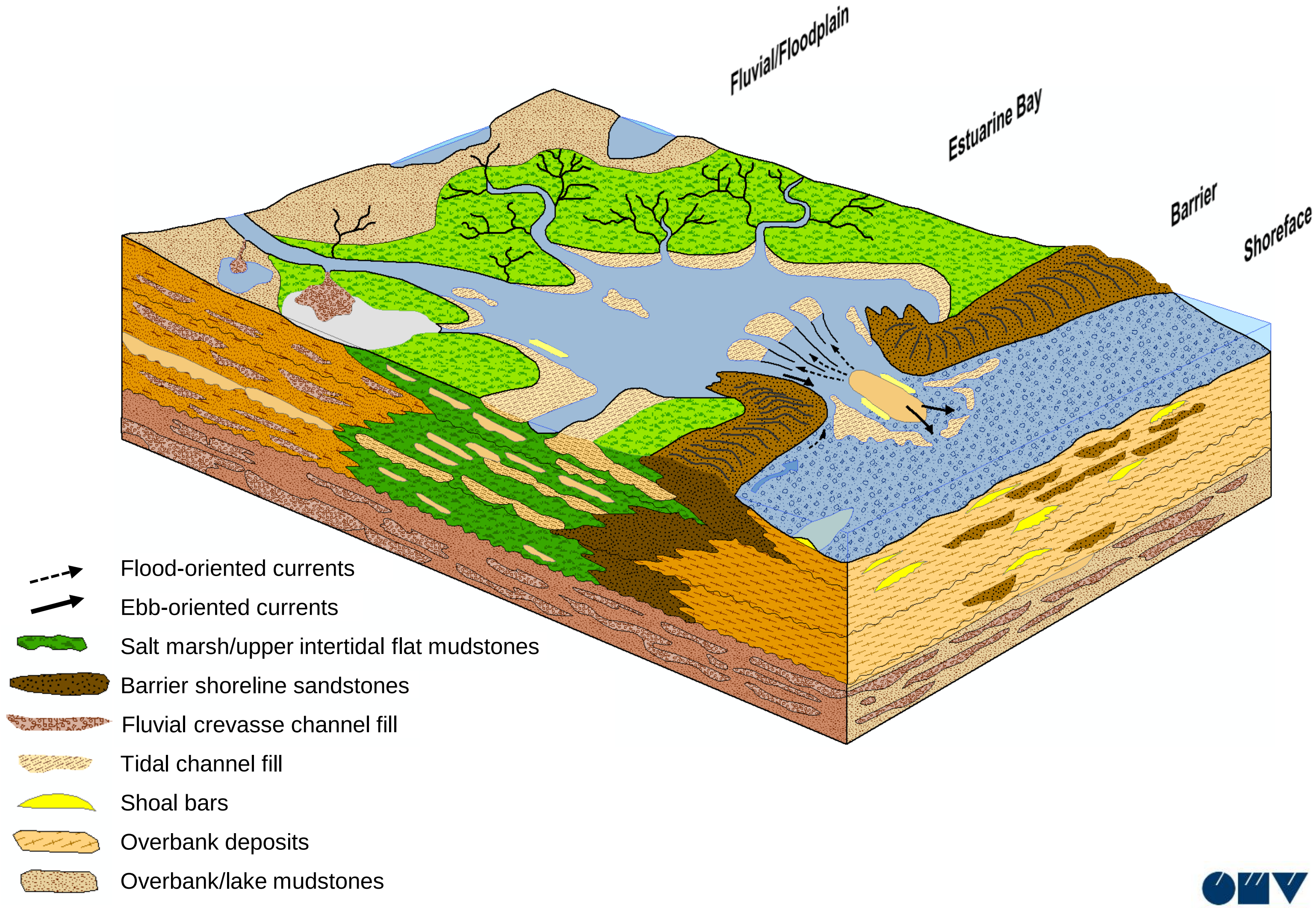
Depositional environment

Sarmatian

Stacked retrogradational parasequences plus more muddy coastal plain sediments with lesser channel deposits when compared to shallower sequences.

Badenian

Generally, sediment transport from NW combined with transgression/regression cycles (Kreutzer, 1986).



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Reservoir sedimentology, example well Hochleiten

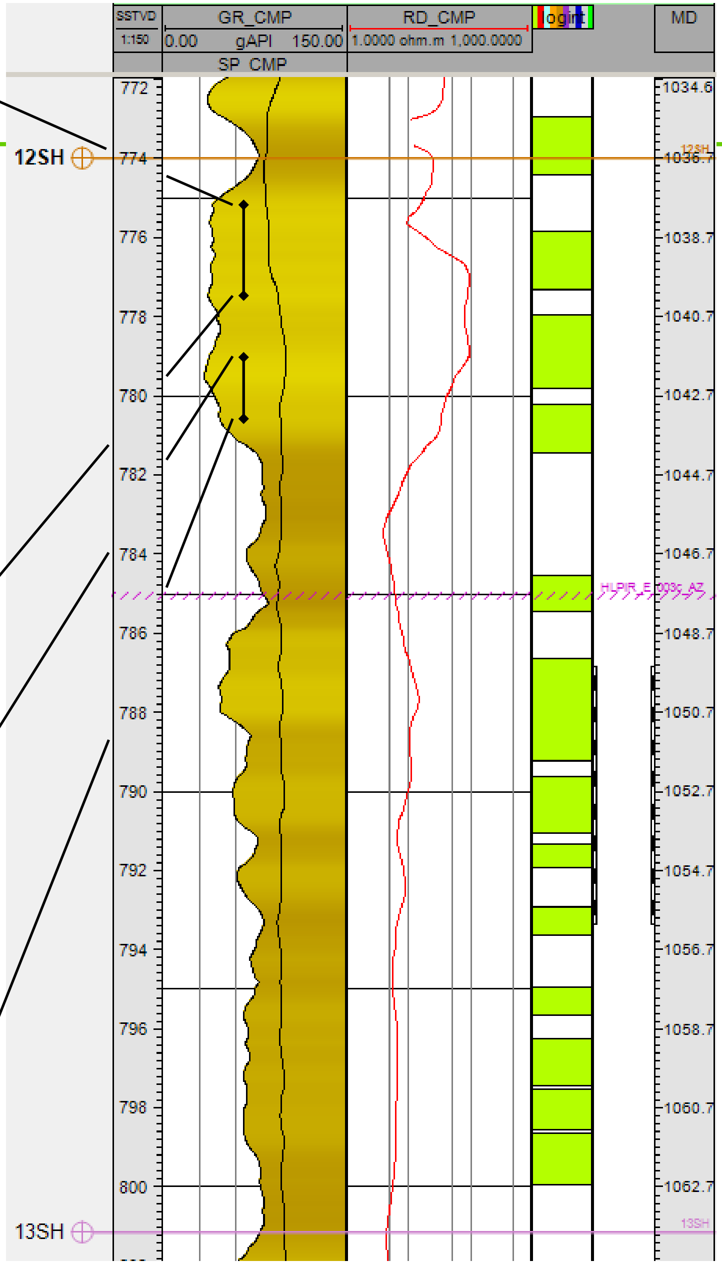
Core 3

- 1042-1045 m MD (in the 12.SH)
- Coastal plain sandstones
- Oil impregnated, fine- to medium-grained sandstone
- low angle cross-lamination
- Av. por. 26%, av. perm 1900 mD

1.85 m

- Oil impregnated, fine-grained sandstone
- small-scale cross-bedding
- bidirectional foreset laminae

0.90 m



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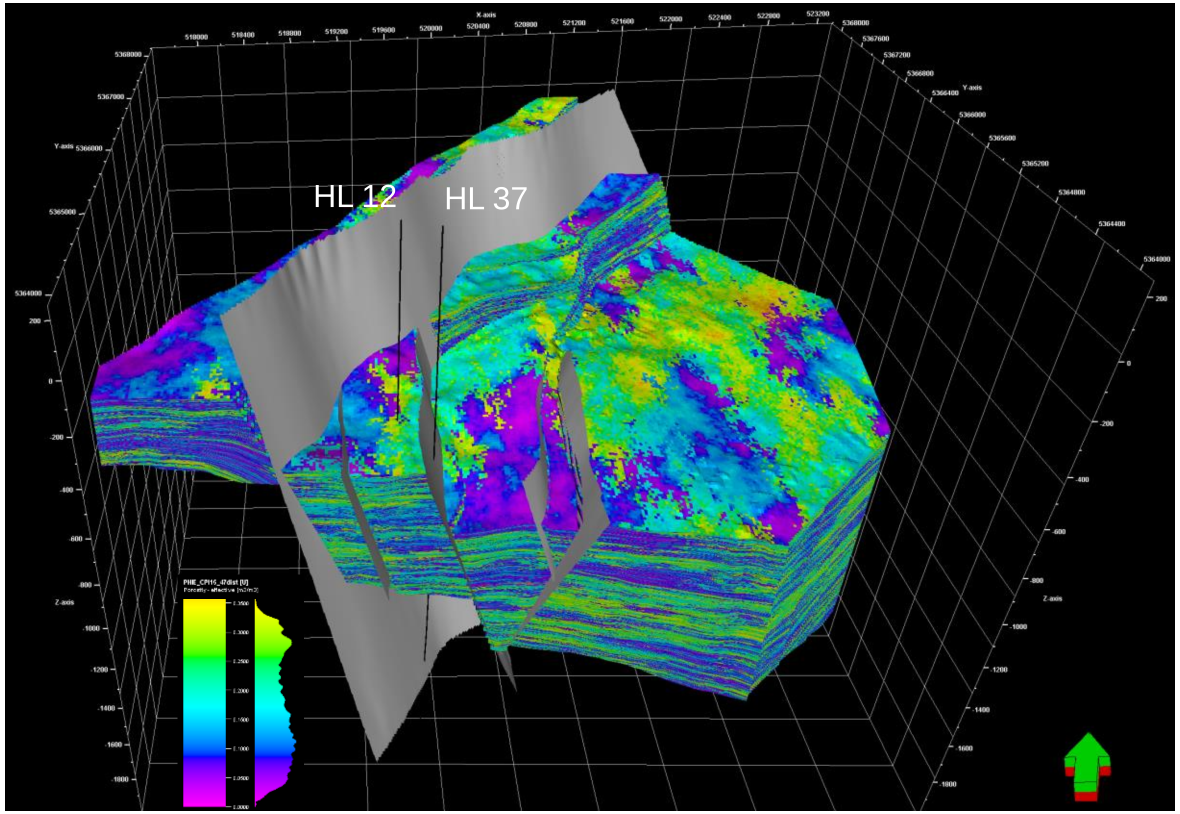
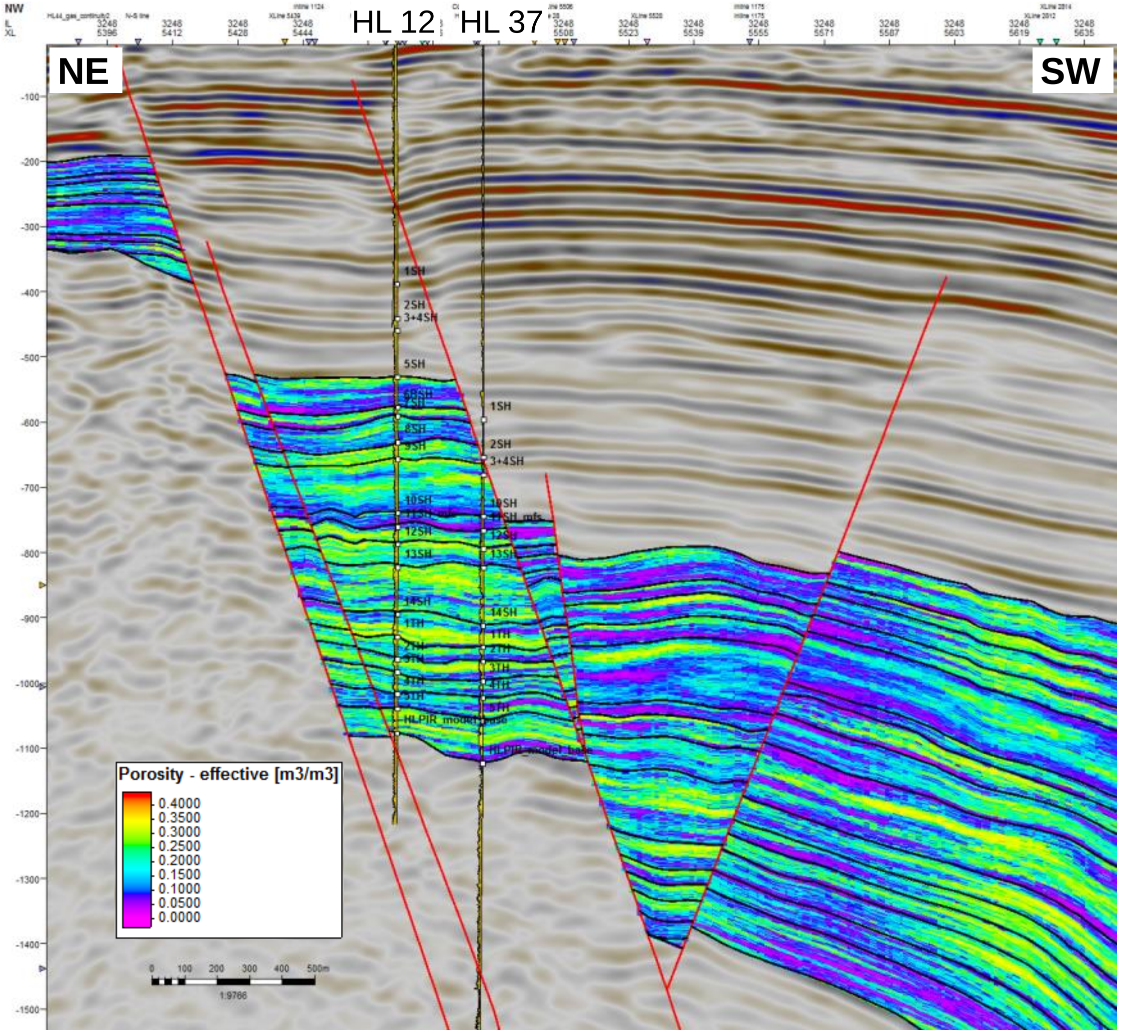
Reservoir model (porosity)





- Effective porosity, conditioning to a net reservoir volume
- Cutoff values: PHIE > 15 % and Vsh < 47%
- Variogram settings adjusted for each horizon

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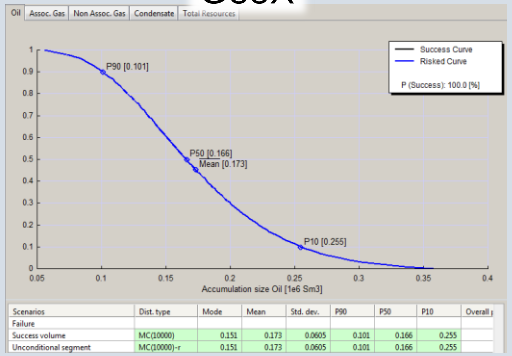
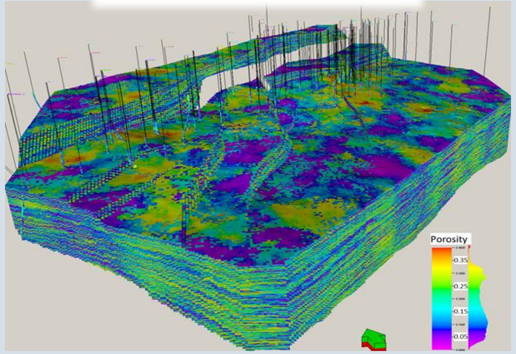
Volume estimation Hochleiten-Pirawarth Fields

- High priority for future production estimations.
- Different volume calculation methods (G&G and RE) to achieve robust results.

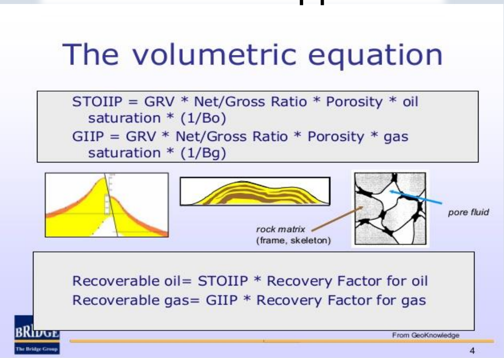
GeoX



Petrel static model



Deterministic approach



- Outcome cross-checked by a simple deterministic calculation and reviewed by an interdisciplinary team.
- Plot of ranges (P10, P50, P90) against cumulative production of the reservoir.
- Display of the achieved production, estimation of the RF and assessment of future production potential.

Input data for G&G methods

Petrophysics
- Contacts
- Gross reservoir thickness
- Net to gross
- Swi
- Porosity

Reservoir engineering
- FVF
- GOR
- Contacts

Petrel Static Model
- Area vs. depth
- Gross reservoir thickness
- Region blocks
- Each reservoir considered
- Porosity property
- NTG property

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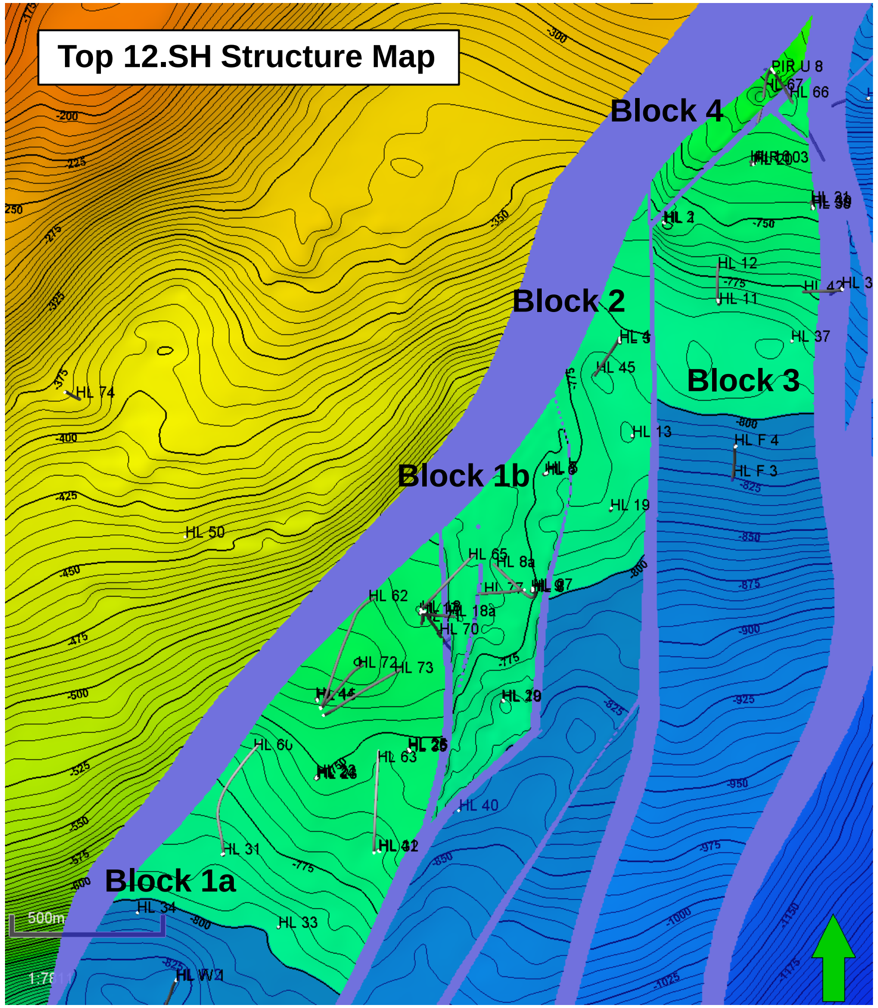
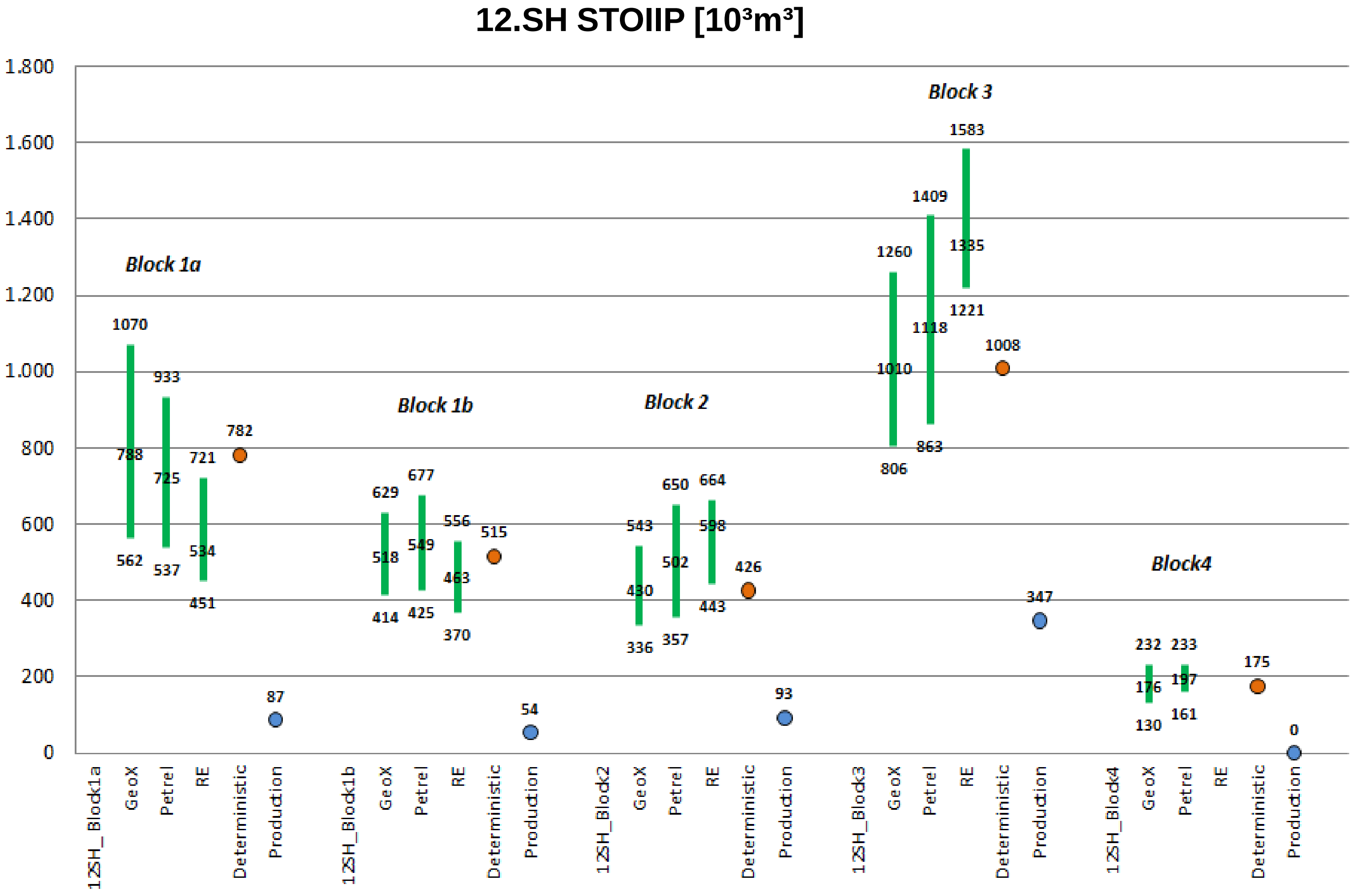
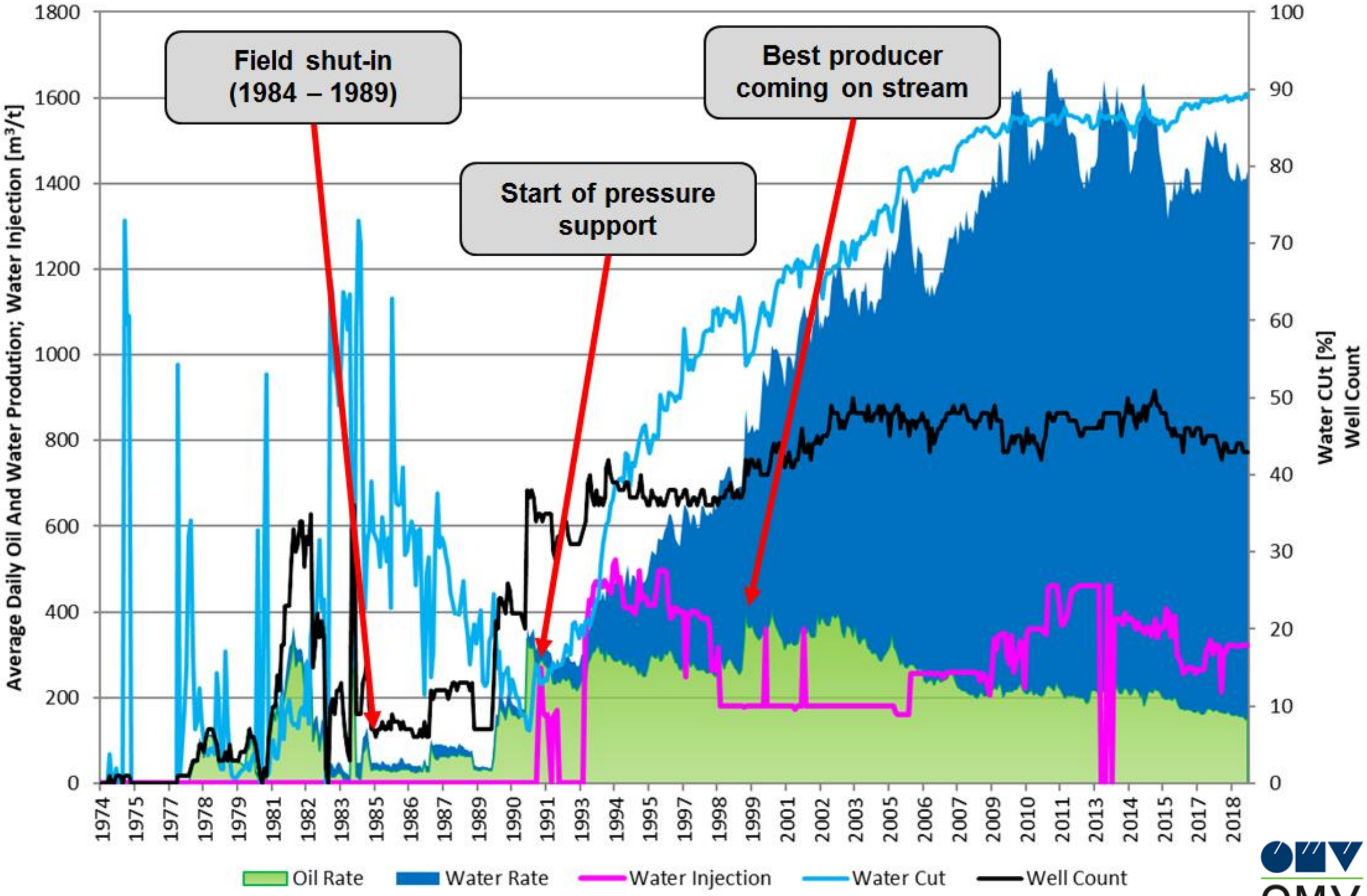
Volumes – example Hochleiten 12.SH





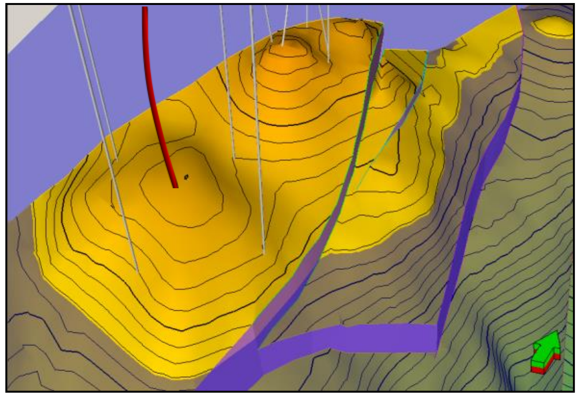
Exemplary production profile - Hochleiten

- Slow decline in oil production
- High water cut of 80-90%
- Almost complete shut-in from 1984 to 1989
- Relatively weak aquifer support
  - Pressure support by water injection starting 1990
- Best producer coming on stream in 1999
  - Additional production from Badenian Horizons

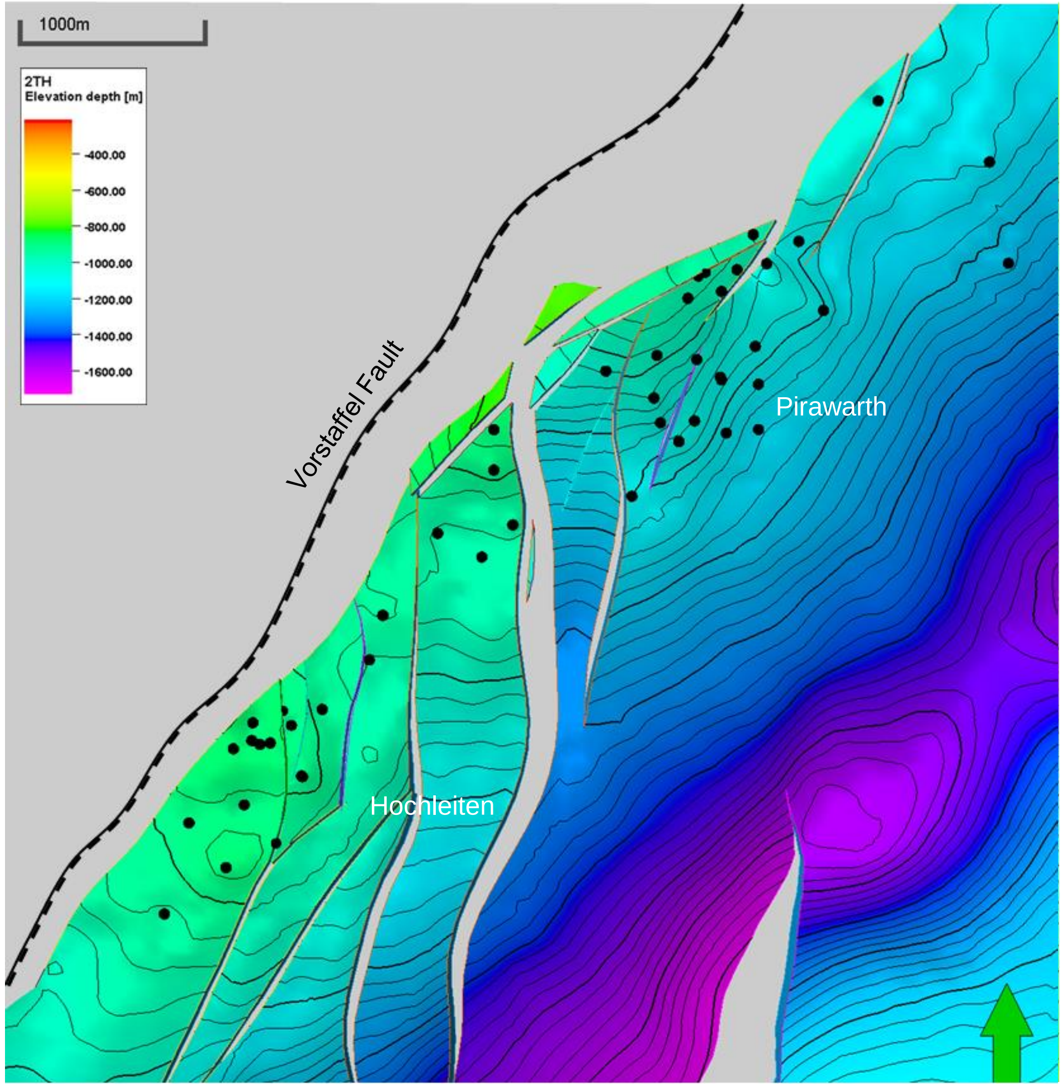


What is left to be done after 62 years of production?

- Target attic oil



- Target so far undrained horizons/ compartments
- Perforate so far undrained layers
- Review potential in deeper horizons



The way forward

Drill an already planned infill well that is based on the holistic view of the Hochleiten-Pirawarth Fields.

Acquire data (NMR, image logs) that allow a thin-bed analysis with the aim to unlock so far hidden potential.

Simulate additional reservoirs and update the field development plans.

Evaluate the potential for further infill wells (producers and injectors) and the economic potential of enhanced oil recovery methods.

Evaluate and perforate so far untapped reservoirs in existing wells.

Update the model after the next well and establish organisational steps to enable continuity.

QC, project managements view

Validation of data-base	Extensive data mining, benefits from previous work
Seismic, re-processing	Tailored to enhance resolution
Seismic, interpretation	Focus on the fault pattern
Attributes	Restricted use
Geology, re-correlation	Tops, seismic and production history in line
Geology, mapping	Strong effort. Next to the model, 23 reference maps established
Petrophysics, re-interpretation	Standardized approach that integrates new measurements
Sedimentology, facies from cores etc.	Reviewed and integrated
Reservoir diagenesis	Reveiewed, more could be done
Structure model	Convincing structure model with improved layering
Property models (por, perm)	Various solutions established
Modeling algorithms	Results compared
Integration of applied RE	Strong effort, all reservoirs and all wells considered
Integration of simulation results	11.SH (main reservoir in HL) simulated; more is possible
Volume calculation	Strong effort, various methods applied and results aligned
Workflows, updateablity	Established, model can be updated
Documentation, reporting	Strong effort, all topics covered

Quality range from unacceptable to fully satisfying: based on project definitions

Persons involved (2015 to 18)

The presented study was planned and carried out as an integrated project. The following persons contributed:

Baric, Nikola	Reservoir engineering
Finsterwalder, Rudolf	Concept, G&G advice, QC and coaching
Haake, Martin	G&G and modelling
Hendizadeh, Hadi	Reservoir engineering
Hujer, Wolfgang	Core analysis advice
Kuffner, Thomas	Core analysis
Leitner, Manfred	RE advice and coordination
Osivandi, Keyvan	G&G and modelling
Schmidt, Dennis	Petrophysics
Schretter, Isabell	Volumes
Steckhan, Jan	Petrophysical advice
Volpini, Sebastian	Reservoir engineering
Zámolyi, Andras	G&G, modelling and coordination

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