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Utilization of abandoned hydrocarbon reservoirs for deep geothermal heat storage

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Motivation

- Room heating and hot water account for the majority of the energy demand of private households
- Abandoned hydrocarbon reservoirs may be utilized for high temperature heat storage as they have already been extensively characterized during their exploration and exploitation
- Their potential for heat storage has not yet been investigated

Conclusion and Perspectives

- Hydrocarbon reservoirs in the Upper Rhine Graben show promising geological and petrophysical properties for geothermal heat storage
- Their detailed potential will be evaluated by developing generic numerical models
- The uncertainties of input parameters and their impact on heat storage potential will be addressed by a sensitivity analysis
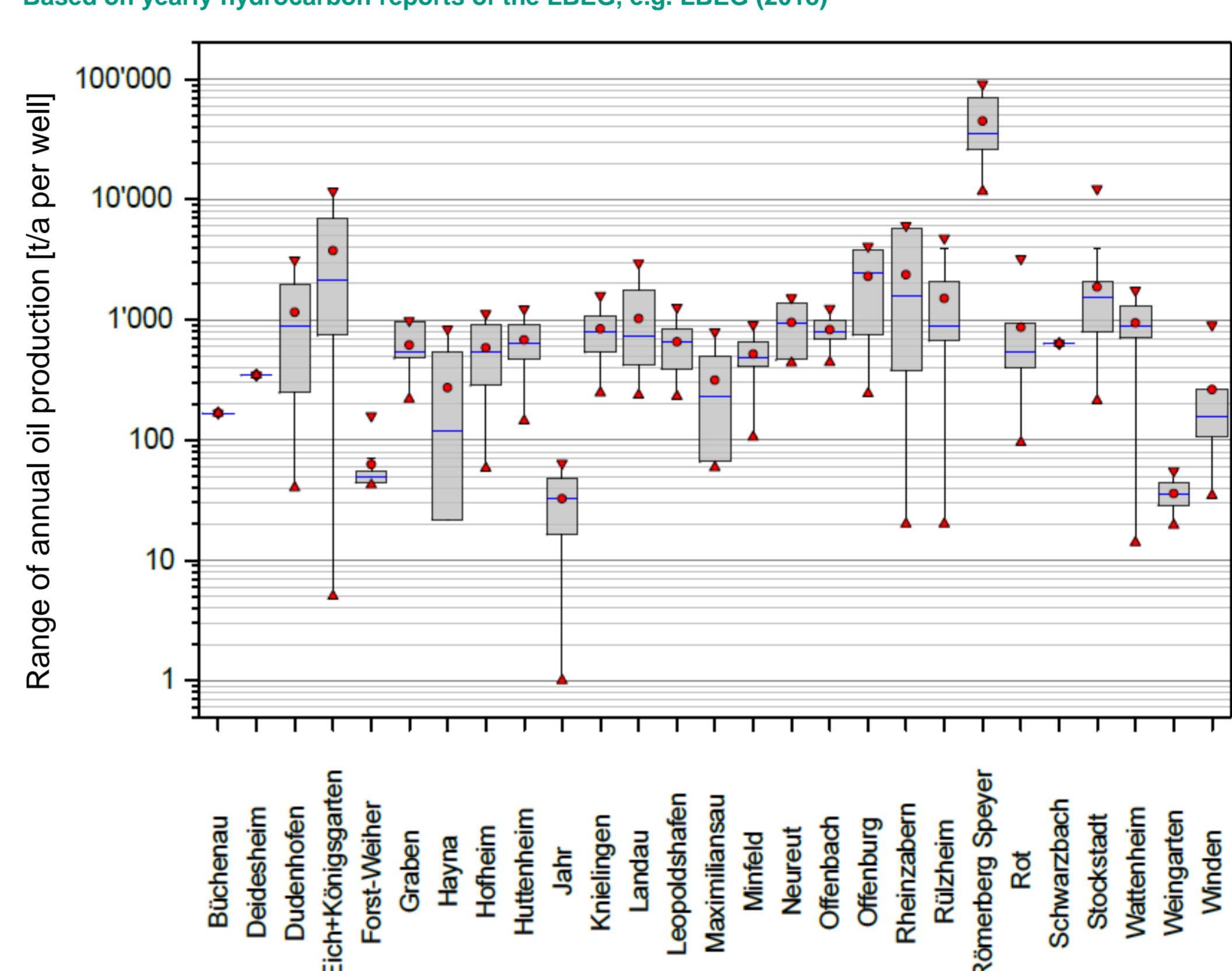
Oil fields in the URG

Location of oil fields in the Upper Rhine Graben, only major fields are labelled.
Modified after Böcker (2015)
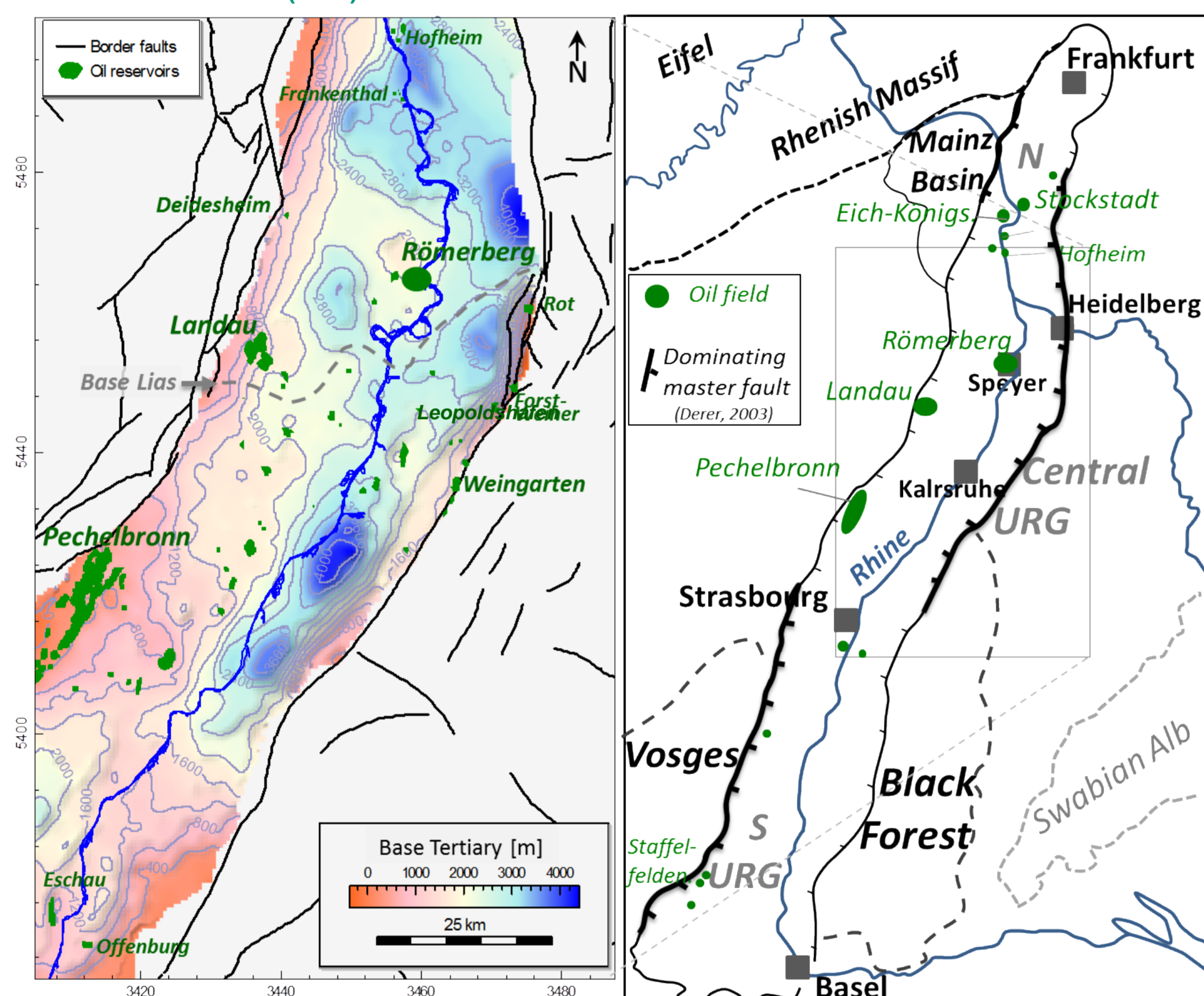
- 27 oil fields in the German part of the Upper Rhine Graben (URG) have been analyzed for their production histories and petrophysical properties, as available
- 4 oilfields still productive in 2018

Overview of the oil production

Overview of the production range of oil fields in the Upper Rhine Graben
Based on yearly hydrocarbon reports of the LBEG, e.g. LBEG (2018)

- The majority of Cenozoic oil fields in the URG produce between 100 and 10000 tons of oil per year and well
- The production of Römerberg/Speyer (Mesozoic reservoir) is one order of magnitude higher (up to 100000 tons of oil per year and well)

Key points
for heat storage in former oil fields

- new technology for energy transformation
- worldwide potentials
- large storage volumes, known geometries
- cost effective investment to storage ratios
- well-known petrophysical reservoir properties
- high-temperature storage possible

## Case study: Leopoldshafen

Production history of the Leopoldshafen oil field
Based on yearly hydrocarbon reports of the LBEG, e.g. LBEG (2018)
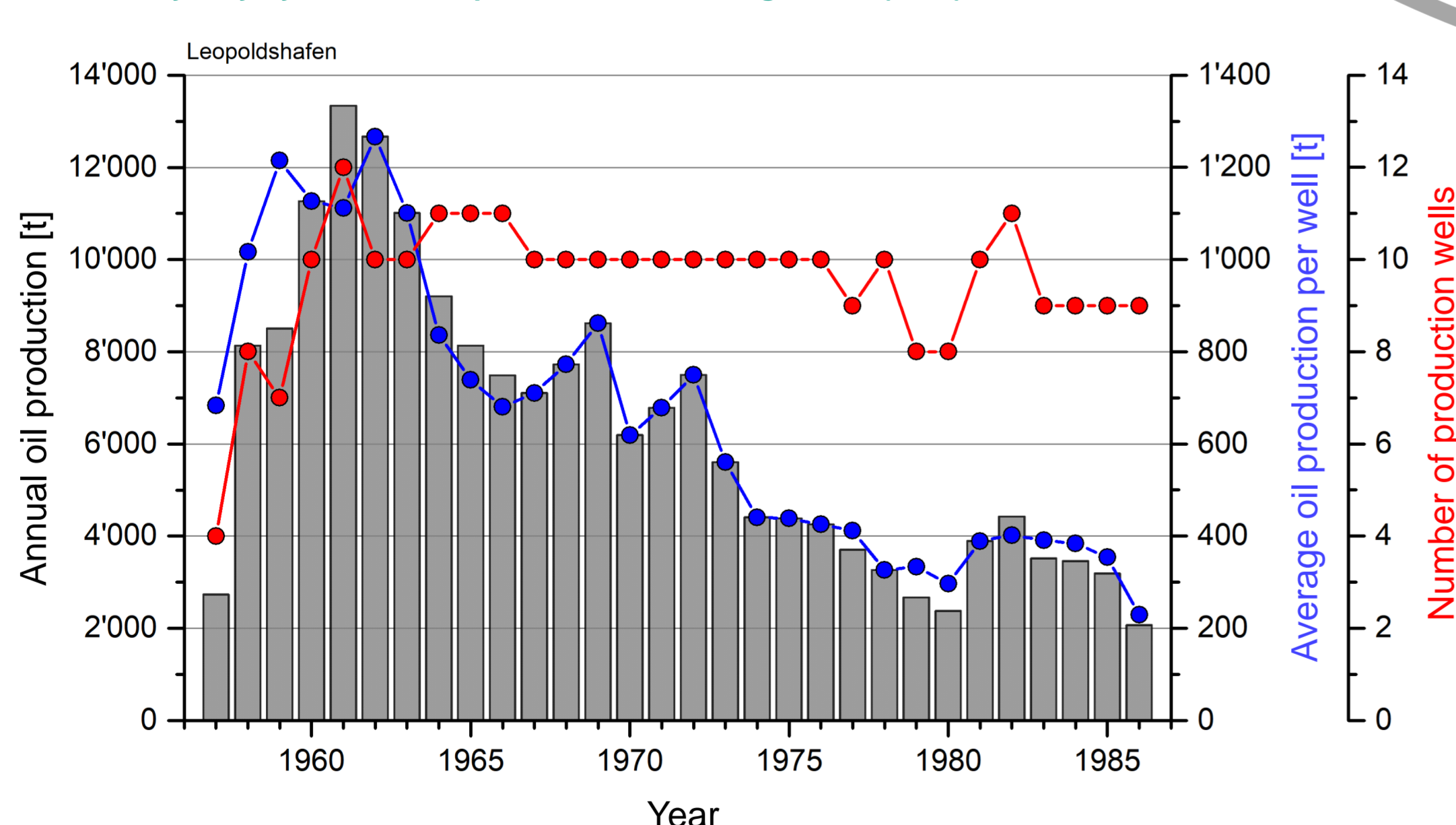
- most oil fields show typical production history patterns: A rapid increase of the annual production, followed by a slower decrease of production (tailing) before oil production was shut down
- number of production wells typically also increases during the first years of production before reaching a ±constant number

Reservoir petrophysics

Crossplot of porosity and permeability for French and German oil fields in the Upper Rhine Graben
Compiled from various studies
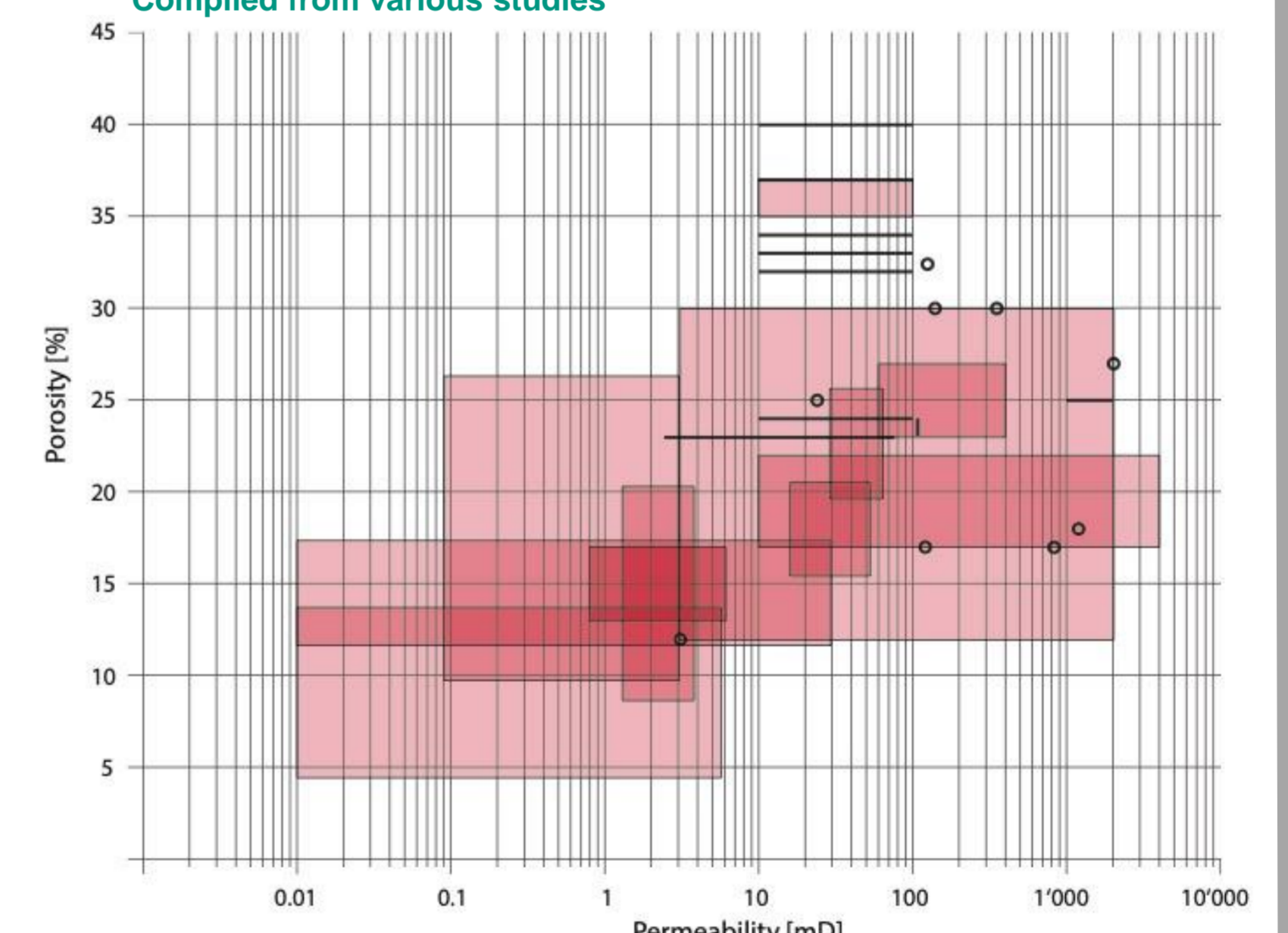
Porosity vs. depth for oil fields of the URG
Compiled from various studies
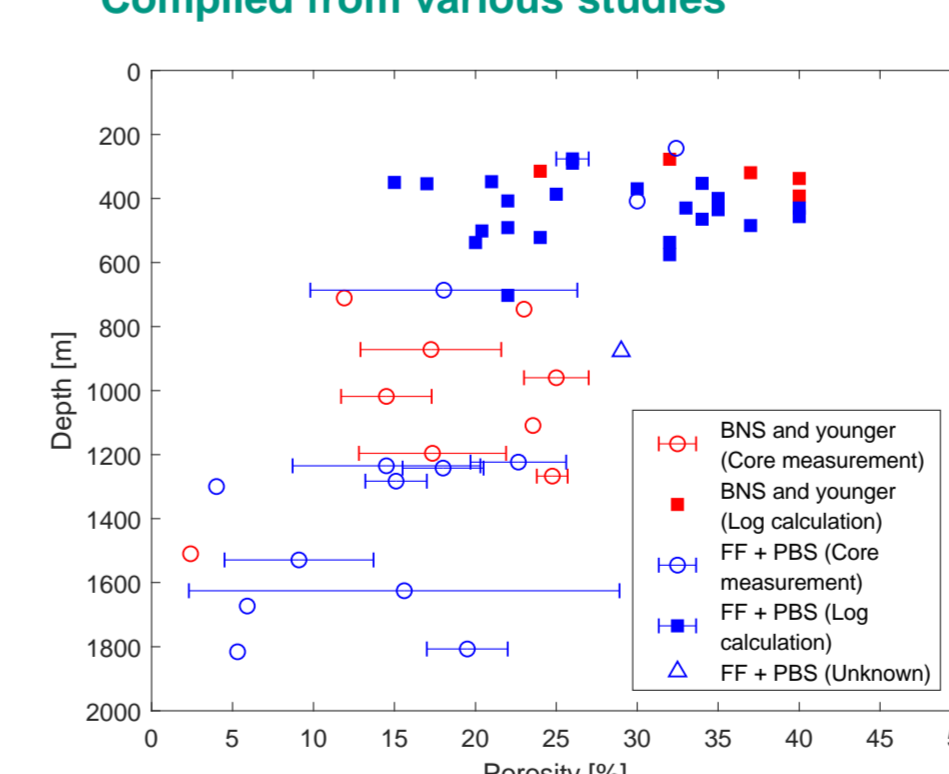
- most reservoirs in Cenozoic sandstones show porosities of 10 to 20%
- associated permeabilities vary from 0.1 to 100 mD
- data show a non-linear relationship between porosity and permeability
- decreasing trend of porosities with depth
- porosities >30% need to be regarded with caution

References

- Böcker, J. (2015): Petroleum system and thermal history of the Upper Rhine Graben – Implications from organic geochemical analyses, oil-source rock correlations and numerical modelling. Diss. RWTH Aachen.
- LBEG (2018): Erdöl und Erdgas in der Bundesrepublik Deutschland (2018). Niedersächsisches Landesamt für Bergbau, Energie und Geologie (LBEG).