Hydrothermal district heating in Schwerin – reviving the geothermal potential of the North German Basin

Stefan Thiem[1], Marco Wunsch[1], Christian Buse[1], Rafael Mathes[1], Ingmar Budach[1], Matthias Franz[2], Benjamin Kielgas[3], Rene Tilsen[3]

[1] Geothermie Neubrandenburg GmbH
[2] Geowissenschaftliches Zentrum der Georg-August-Universität Göttingen
[3] Energieversorgung Schwerin GmbH & Co. Erzeugung KG

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Geothermal history of Northern Germany

- Development

- 6 heating plants in operation
  - 4 build until 1995
  - 2 build until 2007
- Schwerin started operational trial in 2023

Geothermie.de

Geothermal history of Northern Germany

- Challenges

Exploration risk

main reservoir =
fluvial channel systems

distributional variability
of sandstones

Moderate reservoir temperature (< 60°C)

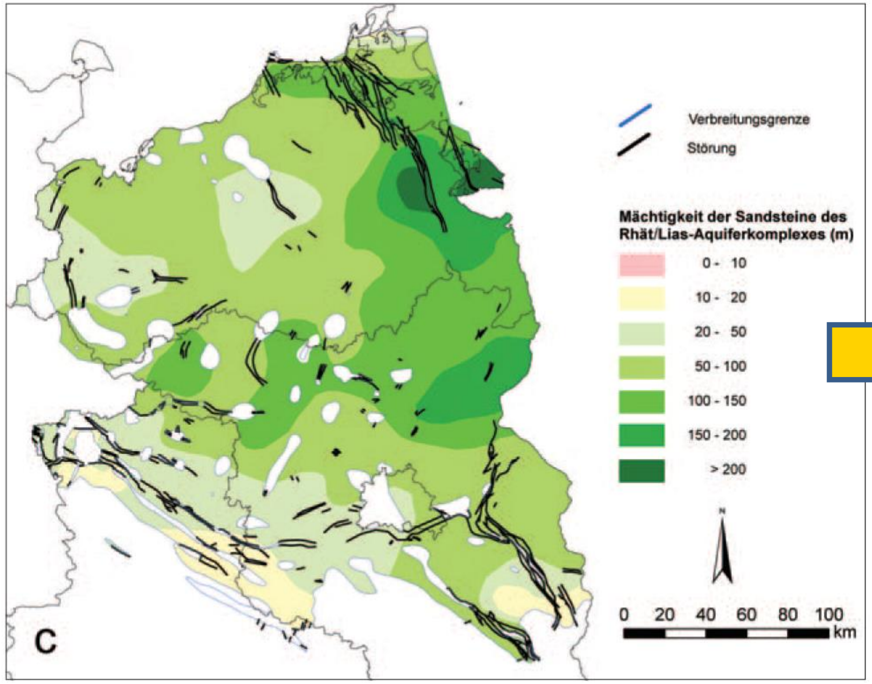
demand > 80 °C
for direct transfer

requirement for
large scale heat pumps

Reduction of exploration risk

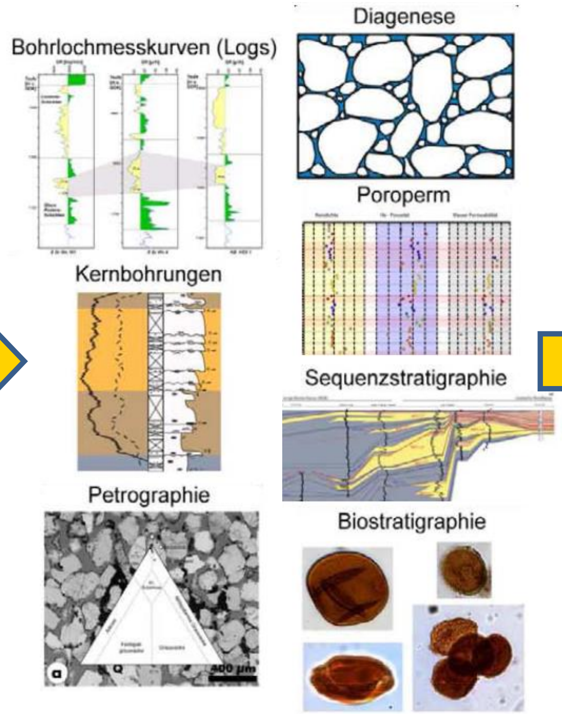
- Development of facies model

classical approach



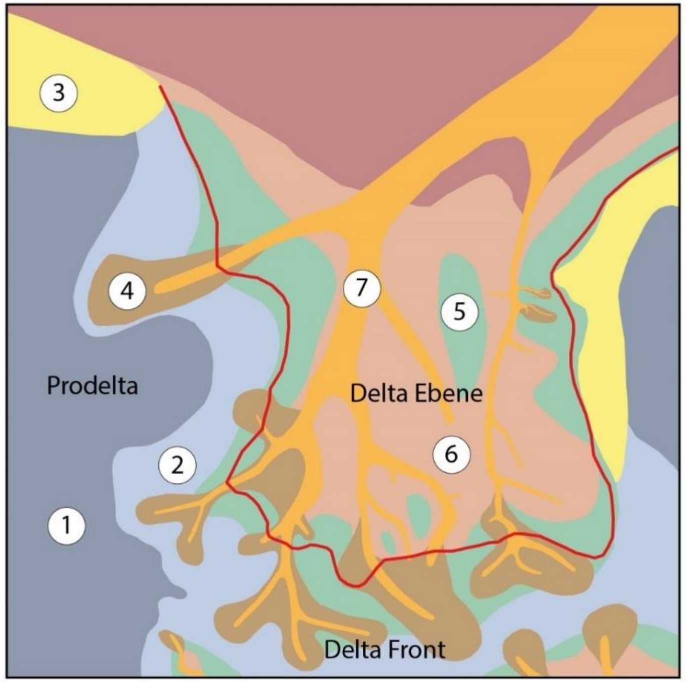
Feldrappe et al. (2008)

advanced reservoir characterization



Franz et al. (2018)

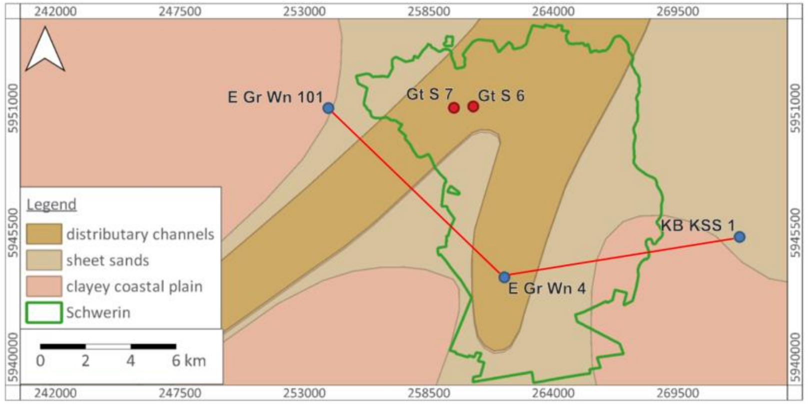
facies model

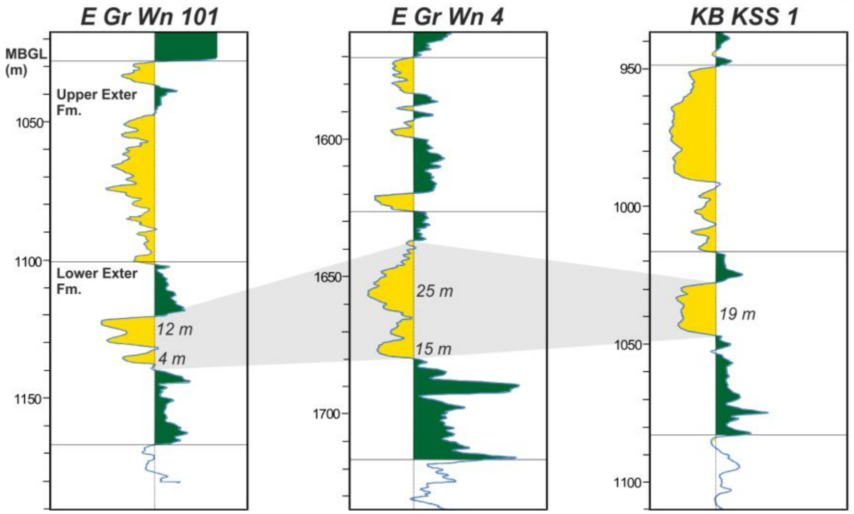


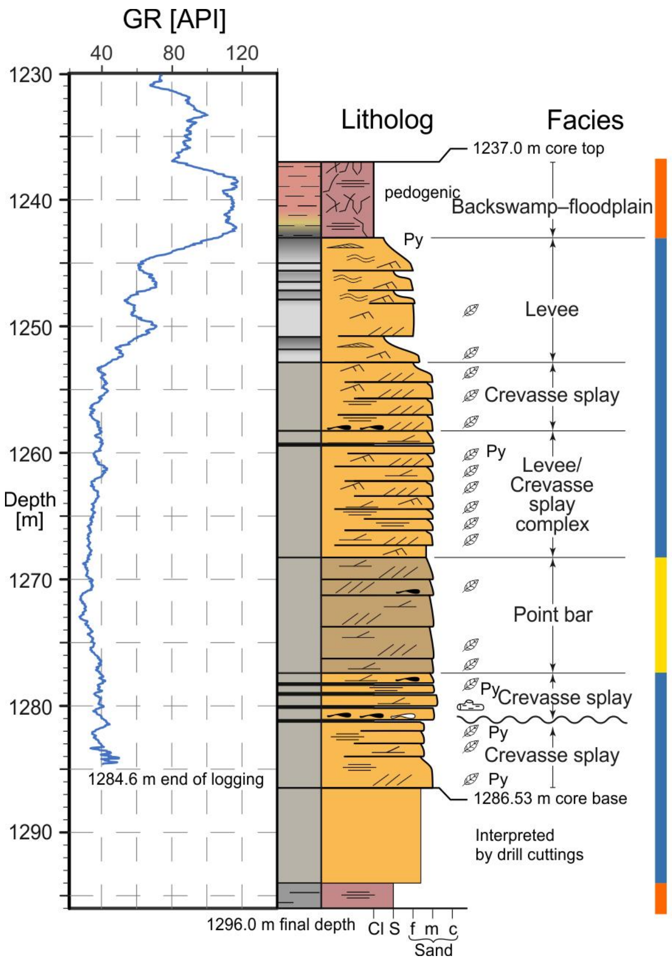
Zimmermann et al. (2018)

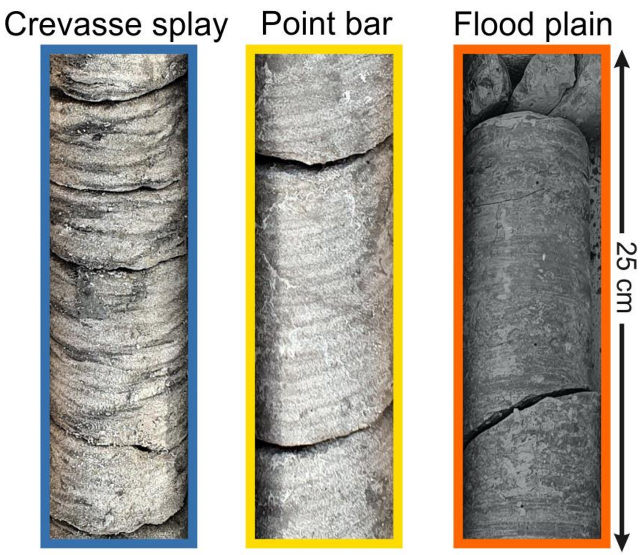
Schwerin Lankow

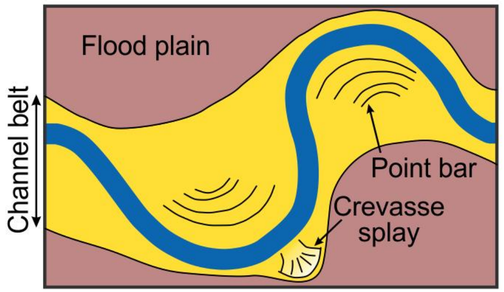
- 1st application of facies model











Schwerin Lankow

Reservoir characteristics

	Schwerin 6	Schwerin 7
Depth - TOP (m TVD)	1,245	1,220
Temperature (°C)	57	56
Thickness (m)	49	42
Porosity (%)	31	23
Permeability (D)	6.2	6.3
Salinity (g/l)	145	147
Productivity (l/s/bar)	35	18

Impressive reservoir quality

- Design paramters heating plant
  - Rate = 42 l/s
  - Production temperature = 55.5 °C

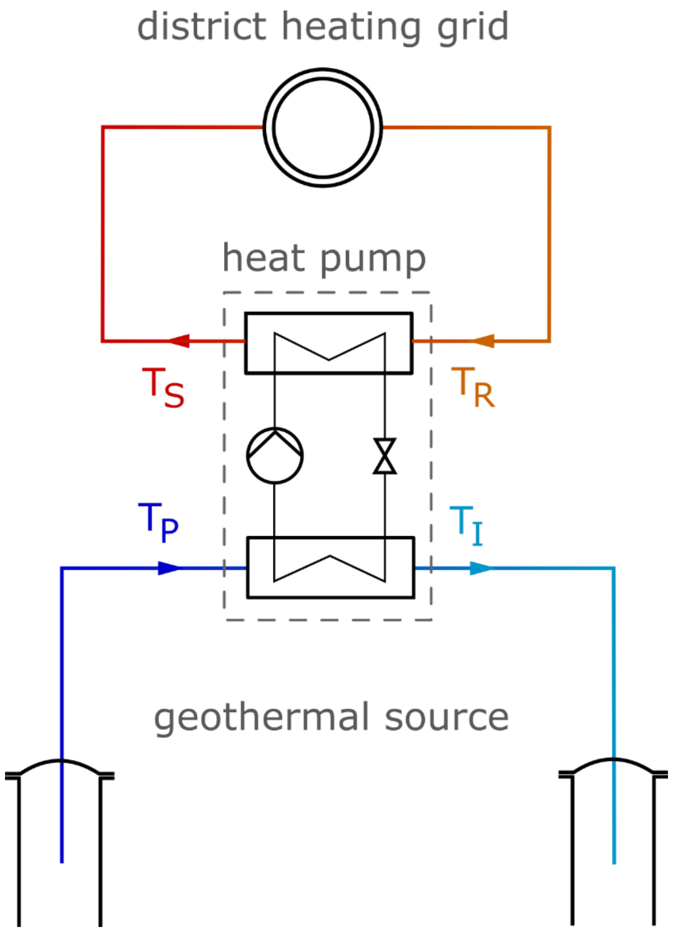
Limitation factors for flow rate

- Reservoir integrity
- Screen design
- Economic costs for pump

Improved knowledge on these factors is major challenge for future development

Moderate reservoir temperature

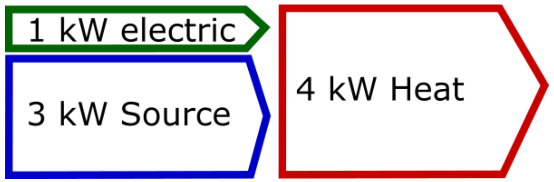
- High temperature large scale heat pumps



- Coefficient of performance

$$COP = \frac{heat\ output}{drive\ power}$$

$$COP = 4:$$



- COP of ideal process:

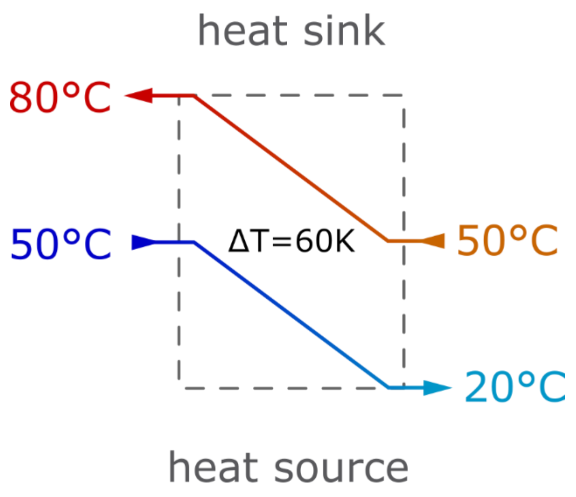
$$COP_{Carnot} = \frac{T_S}{T_S - T_I}$$

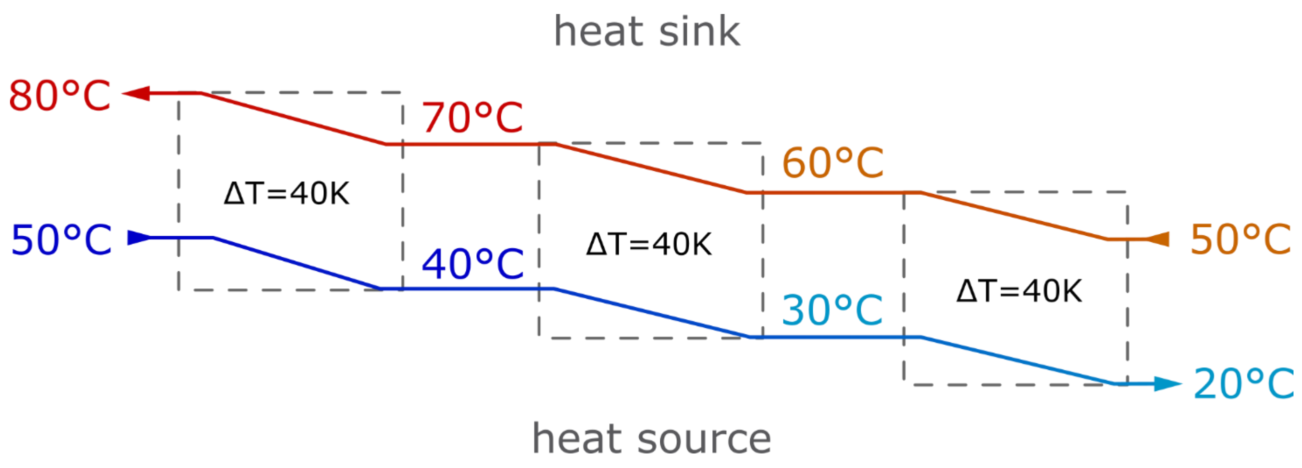
COP= COP_Carnot * factor

Decisive factor is the difference between supply temperature und injection temperature

Moderate reservoir temperature

- COP improvement by cascade connection





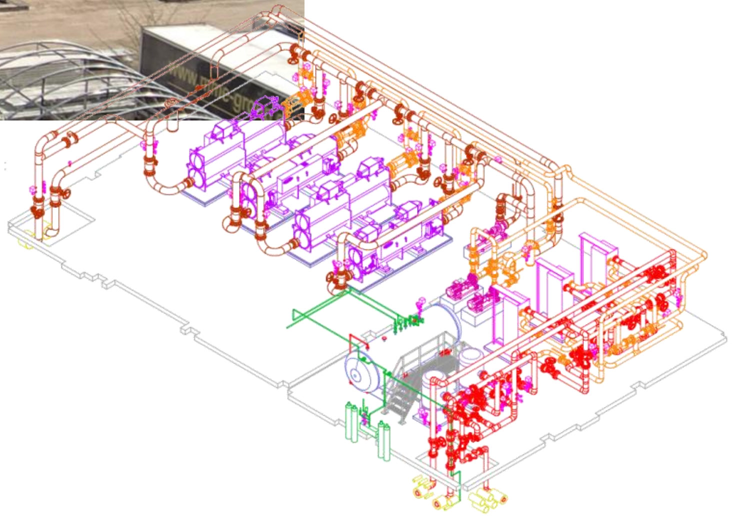
$$COP_{Carnot} = \frac{(80 + 273.15)\ \mathrm{K}}{(80\ - 20)\ \mathrm{K}} = 5{,}89$$

$$COP_{Carnot} = \left(\frac{(80 + 273.15)\ \mathrm{K}}{(80\ - 40)\ \mathrm{K}} + \frac{(70 + 273.15)\ \mathrm{K}}{(70\ - 30)\ \mathrm{K}} + \frac{(60 + 273.15)\ \mathrm{K}}{(60\ - 20)\ \mathrm{K}}\right)$$

$$= (8.83 + 8.58 + 8.33)/3 = 8.58$$

Schwerin Lankow

- 1st application of 4 large scale heat pumps

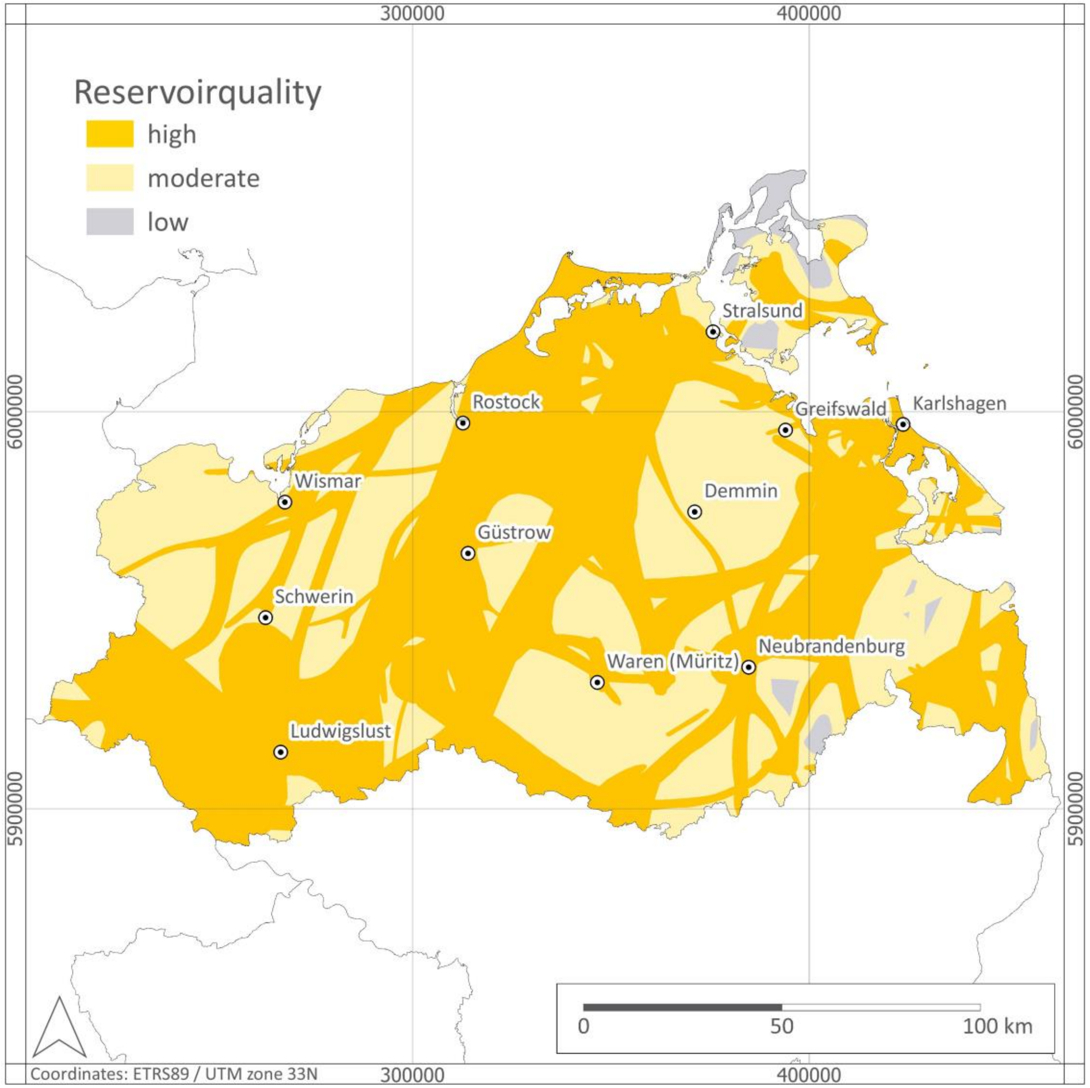


- Flow rate = 42 l/s
- $T_{Production}$ = 55.5 °C

- $COP_{HP\text{-}mean}$ = 4.35
- Heating Capacity $_{max}$ = 7.5 MW
- Heat supply = 60 GWh/a

Economical utilization feasable

Geothermal Potential Northern Germany



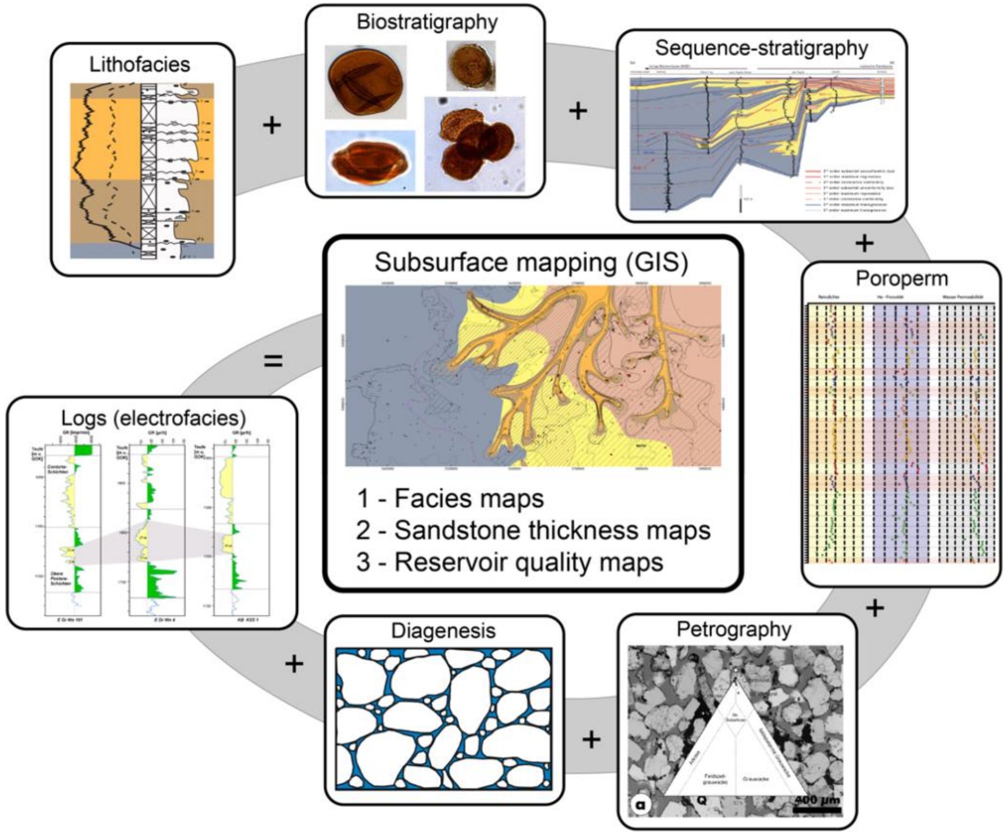
- Exploration risk is redcued due to application of facies maps
- Utilization of moderate reservoir temperatures in combination with large scale heat pumps is economically feasable
- Geothermal reservoirs don‘t need to be as deep as possible

It is time to untap the vast geothermal potential of the North German Basin

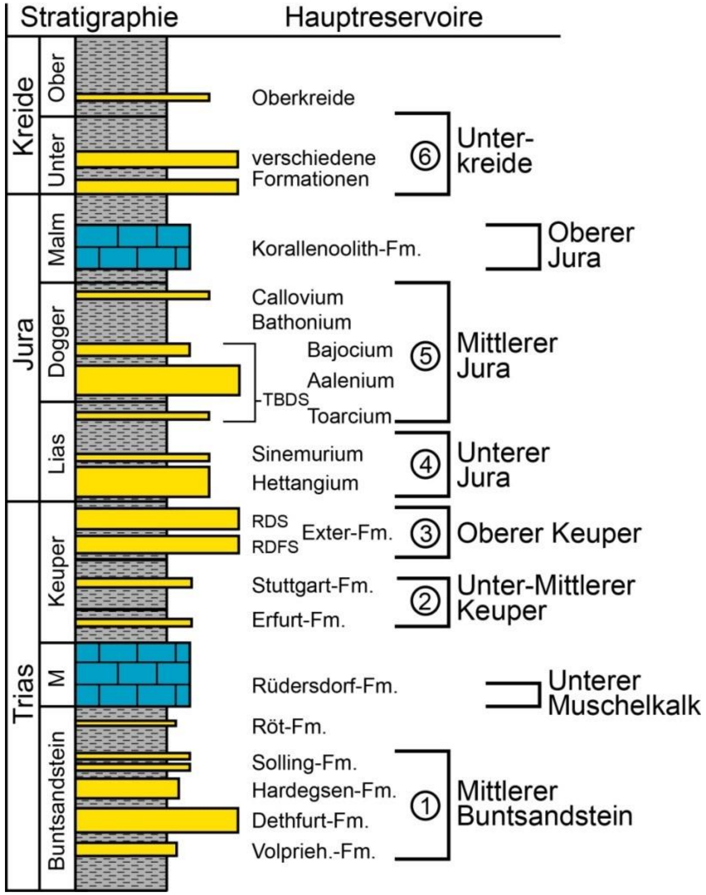
GTN-Online.de

Exploration risk

Facies model

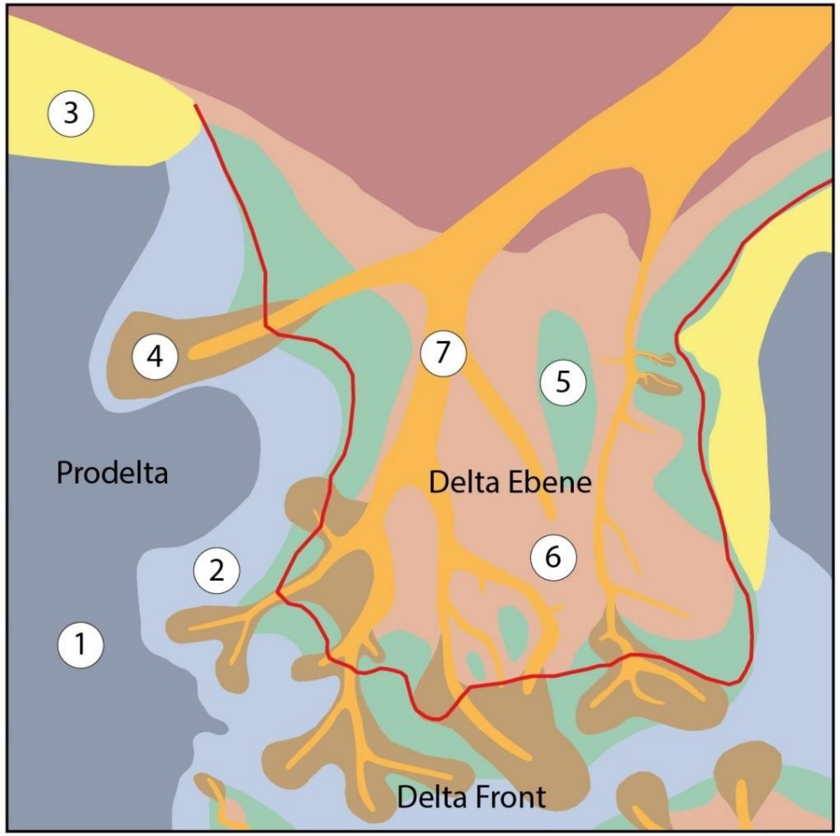


FRANZ et al. (2018)

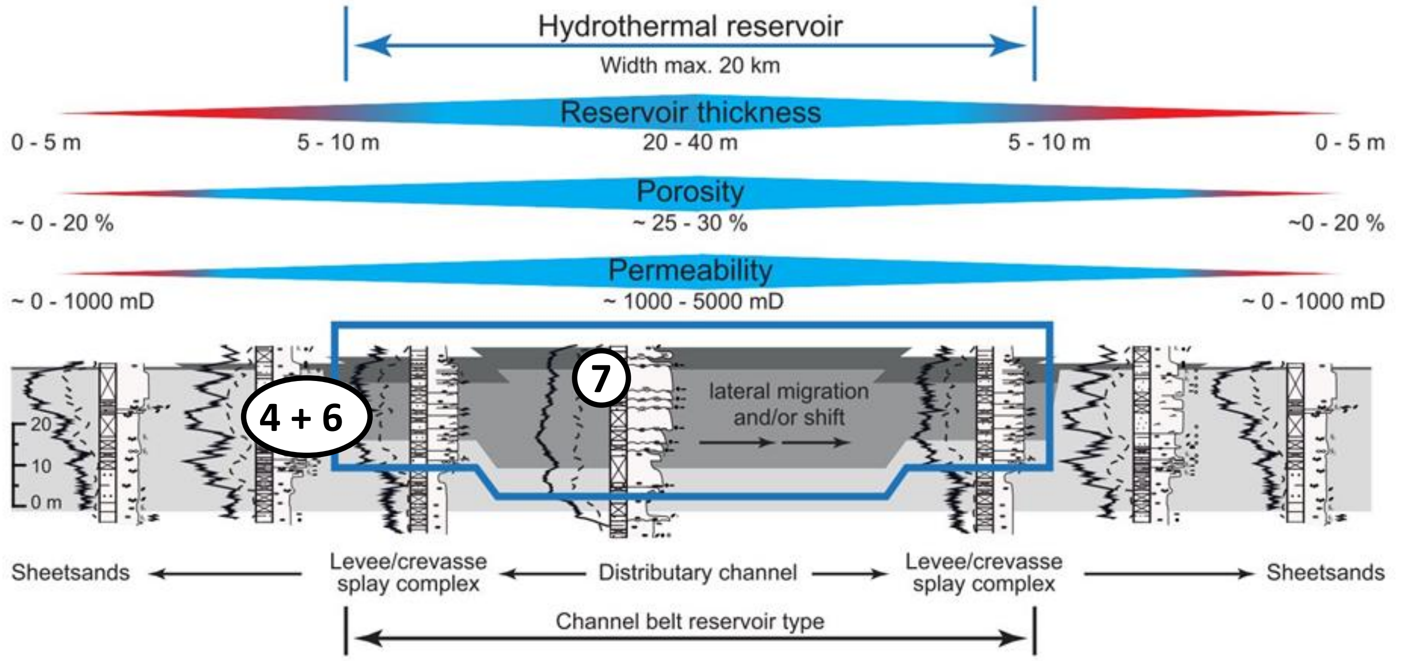


Exploration risk

Facies model



ZIMMERMANN et al. (2018)



WOLFGRAMM et al. (2014)