

Near Surface 2005, Palermo, Italy

Workshop 4. September 2005

Hydrogeophysics – a tool for sustainable use of groundwater resources

Aquifers in glacial deposits: influence of buried valleys and salt domes

H. Wiederhold

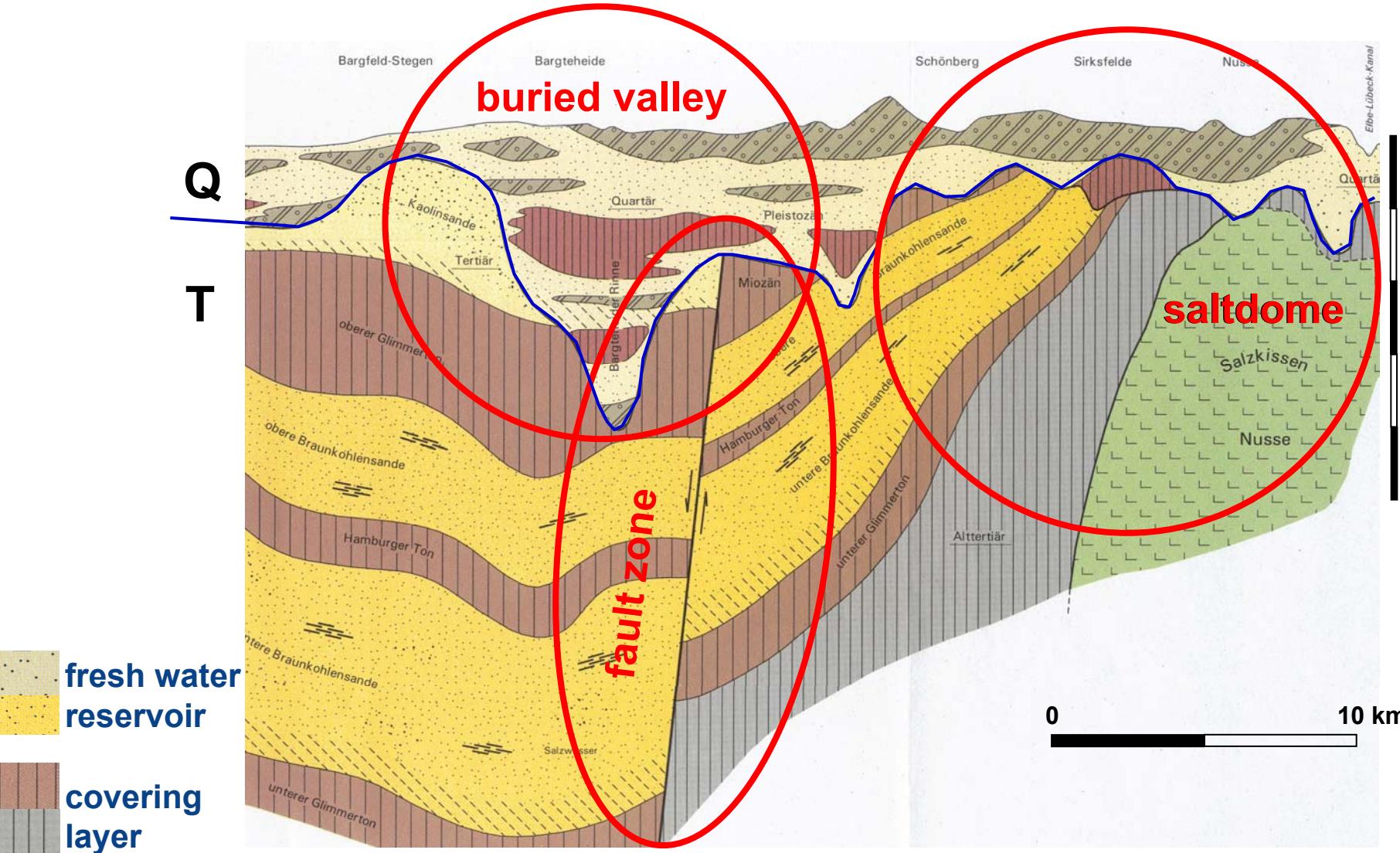
Leibniz Institute for Applied Geosciences (GGA-Institut), Hannover



Aquifers in glacial deposits: e.g. pore aquifers in Northern Germany



Groundwater situation in Schleswig-Holstein



Seismogram

Sweep: 40-160 Hz, 10 s

Ellerbeker Rinne

Parameters:

vertical stack:

4

vP-spacing:

10 m

Seismograph:

StrataView

channels

47

sample interval:

1 ms

Geophone spacing:

10 m

Geophone:

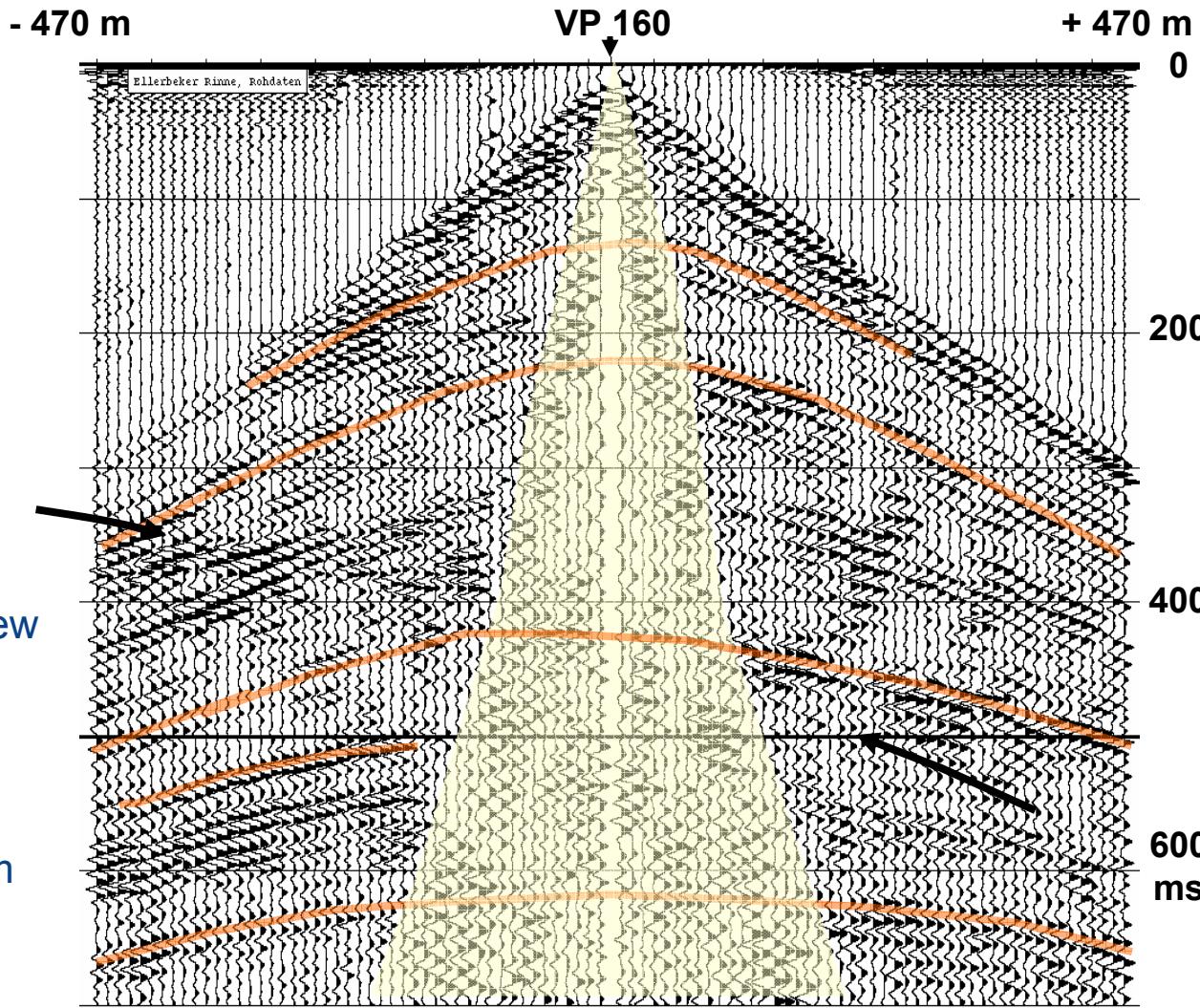
14 Hz

Offset:

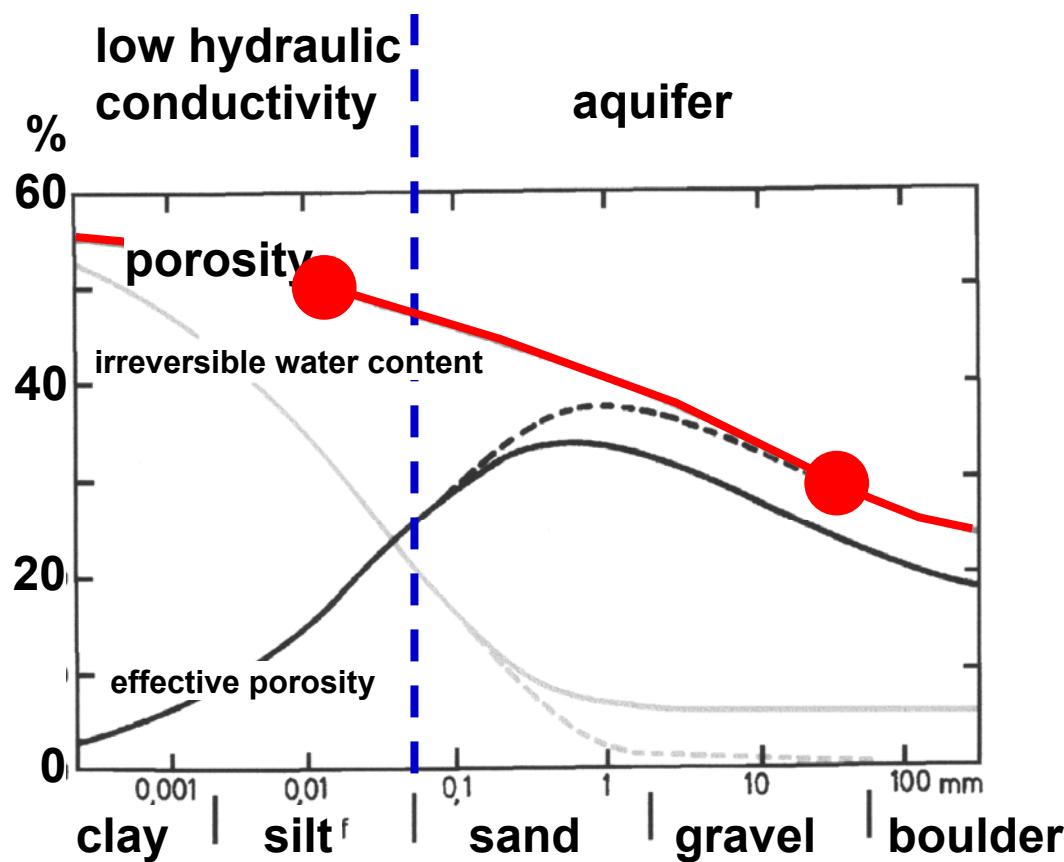
10-470 m

CMP spacing:

5 m

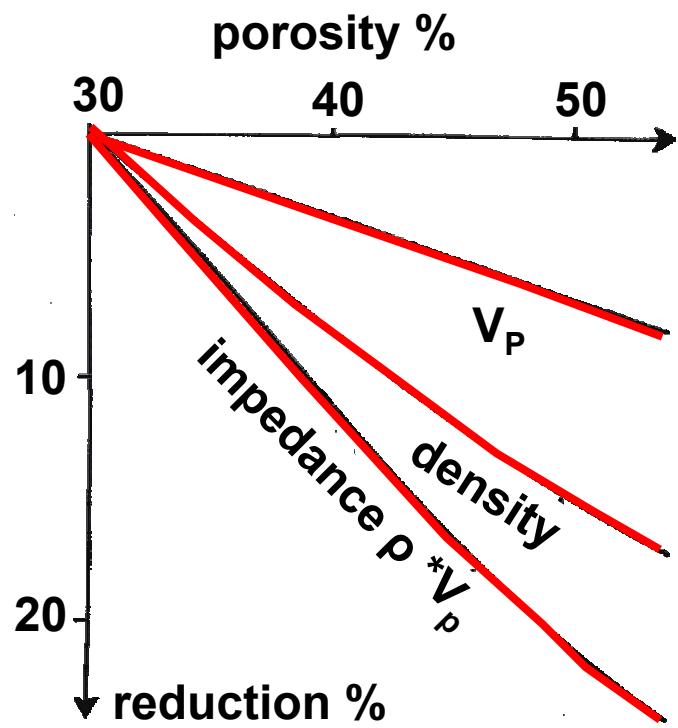


porosity – grain diameter



after Matthess and Ubell 1981

porosity- V_p relation



after Morgan 1969

seismic source: Hydraulic Vibrator



vehicle:

Traction:	4×4, hydrostatic
Engine:	Diesel, 44kW
Max. speed.:	60 km/h
Overall length:	4,0 m
Width:	1,55 m
Height:	1,92 m
Weight:	2600 kg



seismic source: Hydraulic Vibrator



vehicle:

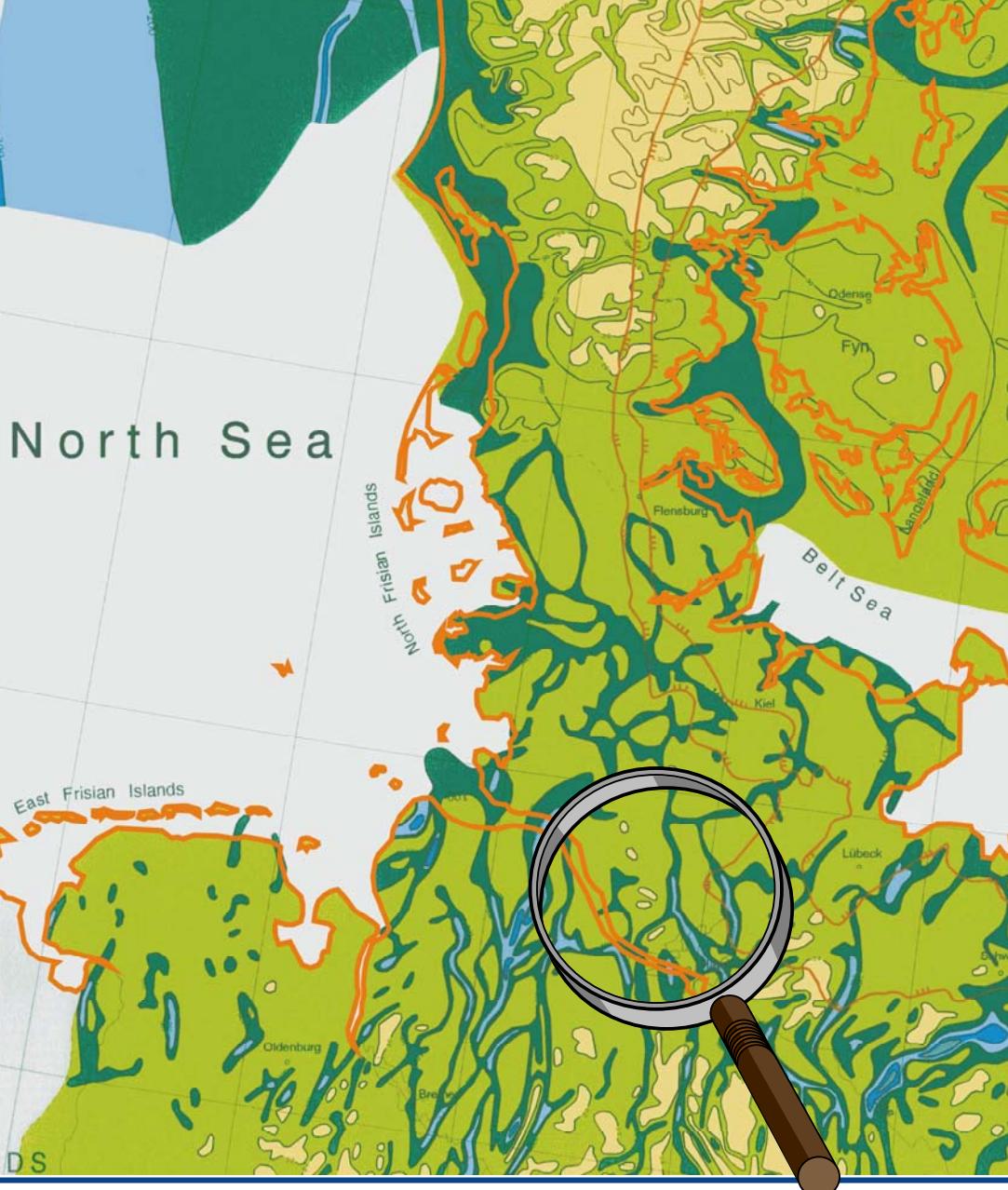
Traction:	4×4, hydrostatic
Engine:	Diesel, 44kW
Max. speed.:	60 km/h
Overall length:	4,0 m
Width:	1,55 m
Height:	1,92 m
Weight:	2600 kg

Vibrator:

Peak force:	27000 N
frequency range:	16 - 500 Hz
Actuator weight:	181 kg
Base plate weight:	138 kg
Base plate area:	0,65 m ²
Mass stroke:	15 mm
System pressure:	220 bar
Vibrator control:	Pelton VIB PRO

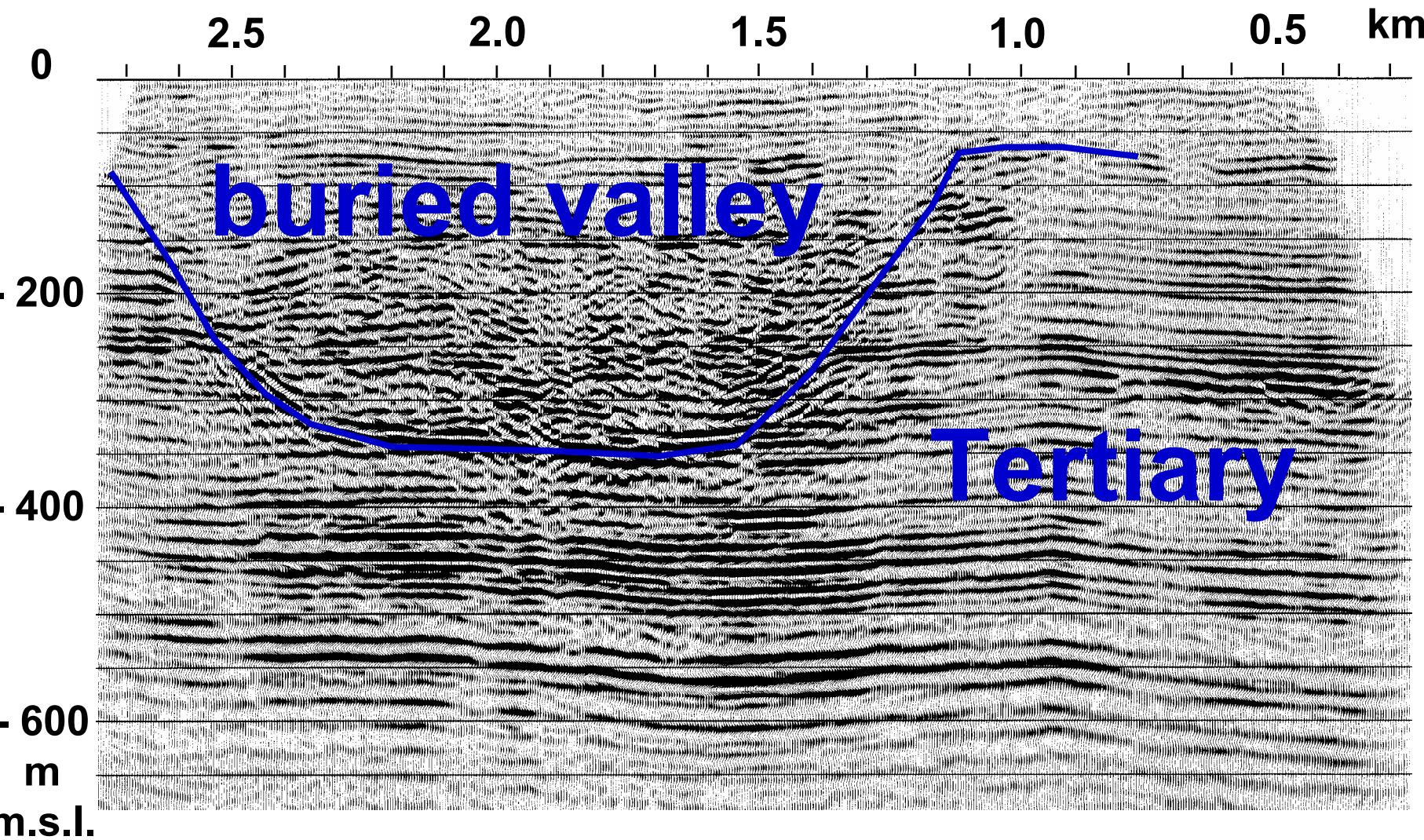
Base Quaternary

Ellerbeker Rinne



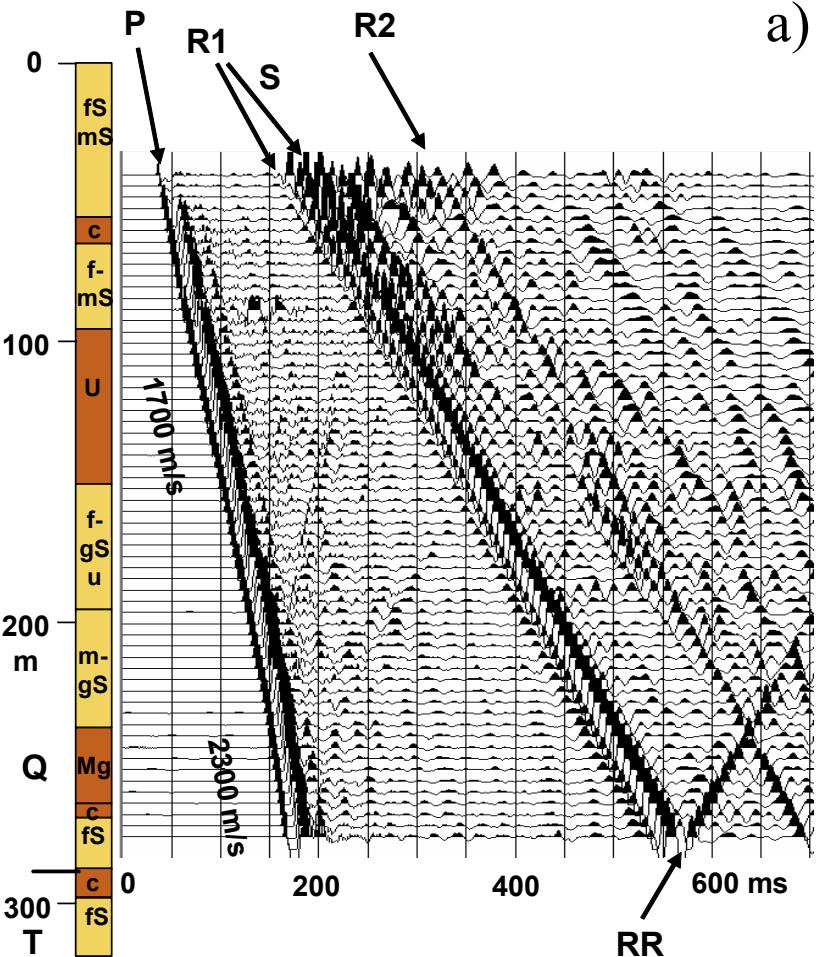
seismic depth section, migrated

Ellerbeker Rinne

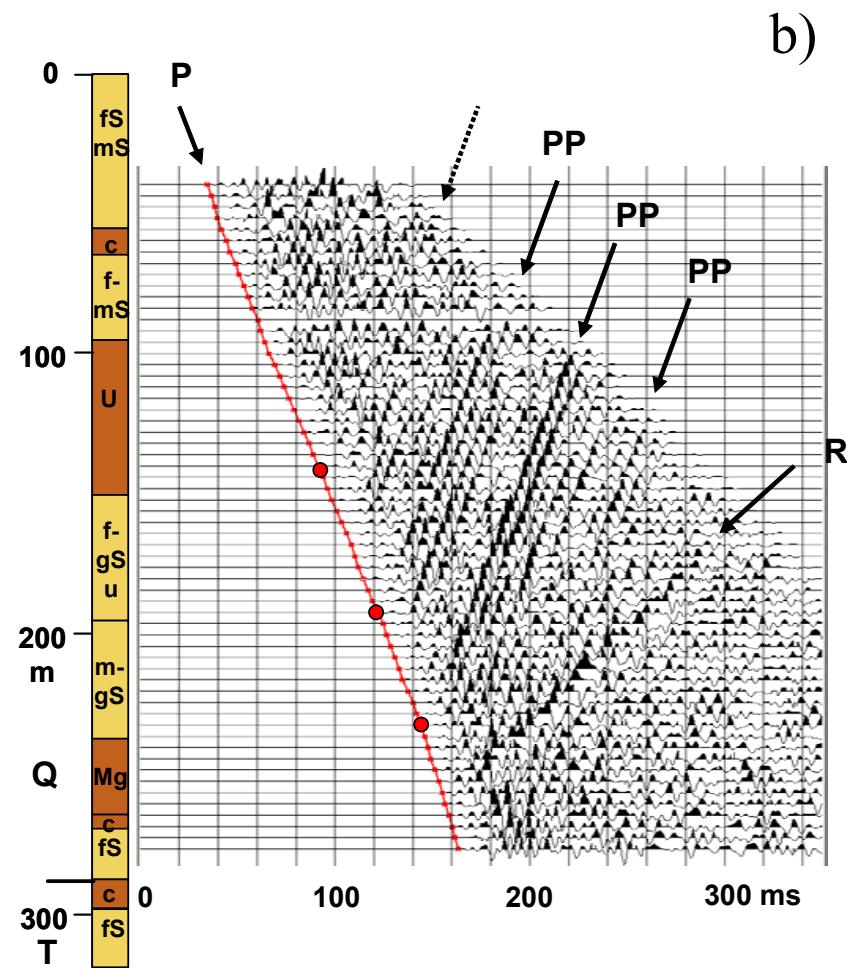


Vertical Seismic Profile (VSP)

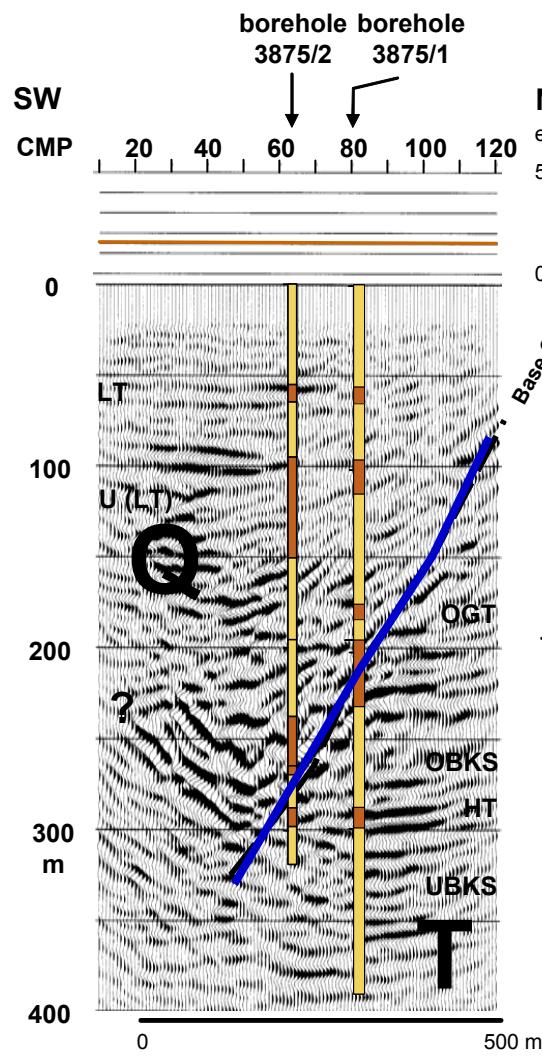
raw data



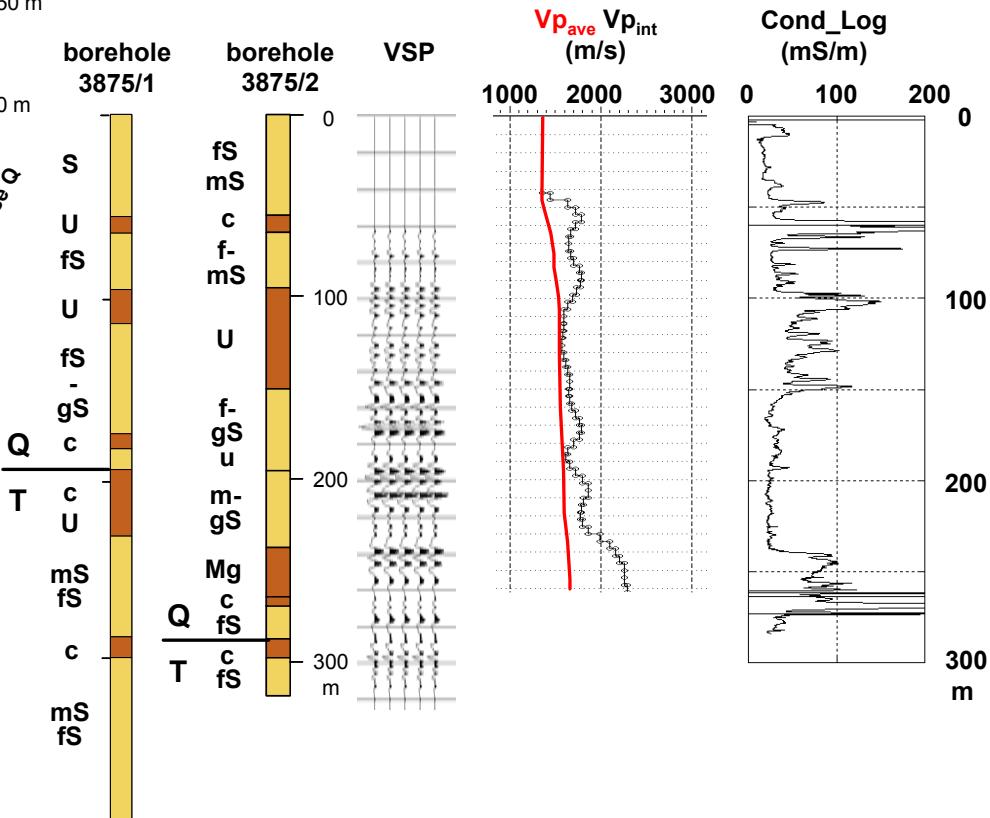
upgoing wavefield



Combination: seismic and borehole

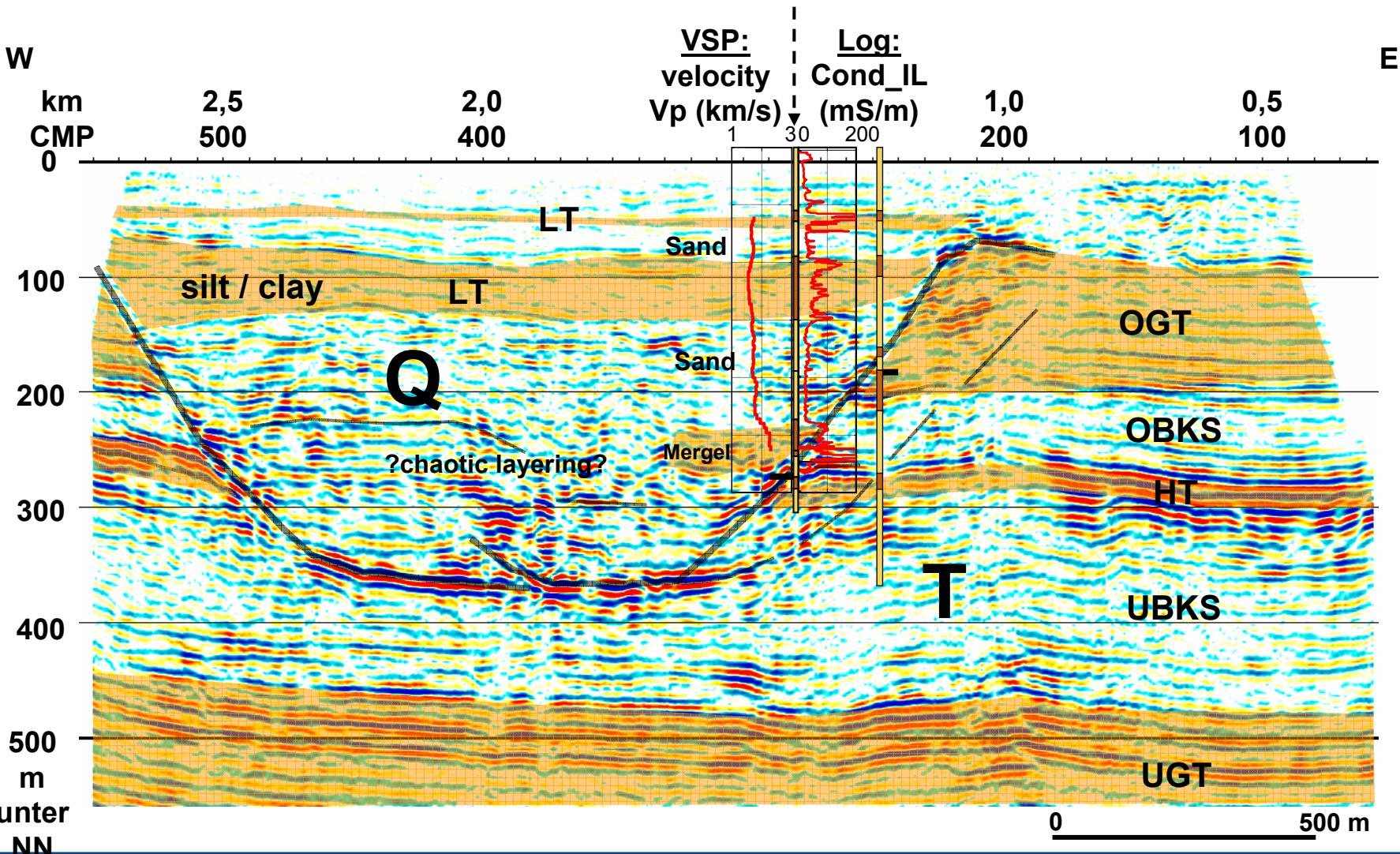


corridor velocity electrical
stack conductivity



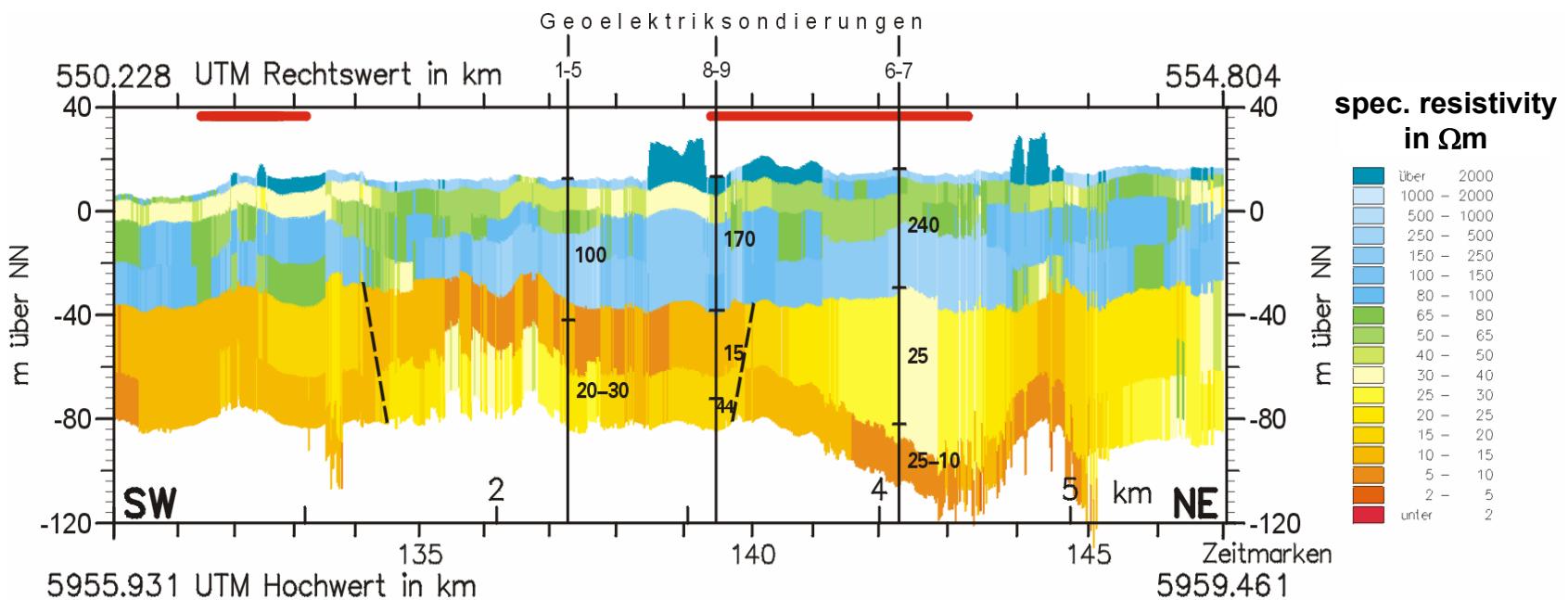
seismic depth section

Ellerbeker Rinne

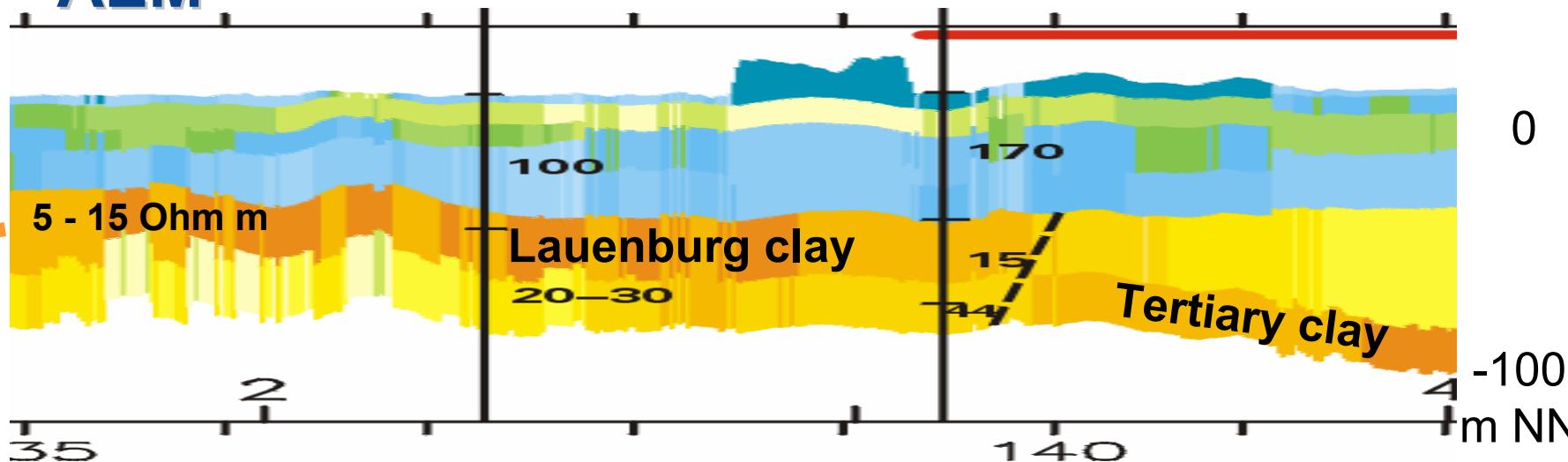


Airborne ElectroMagnetic survey (AEM) resistivity section

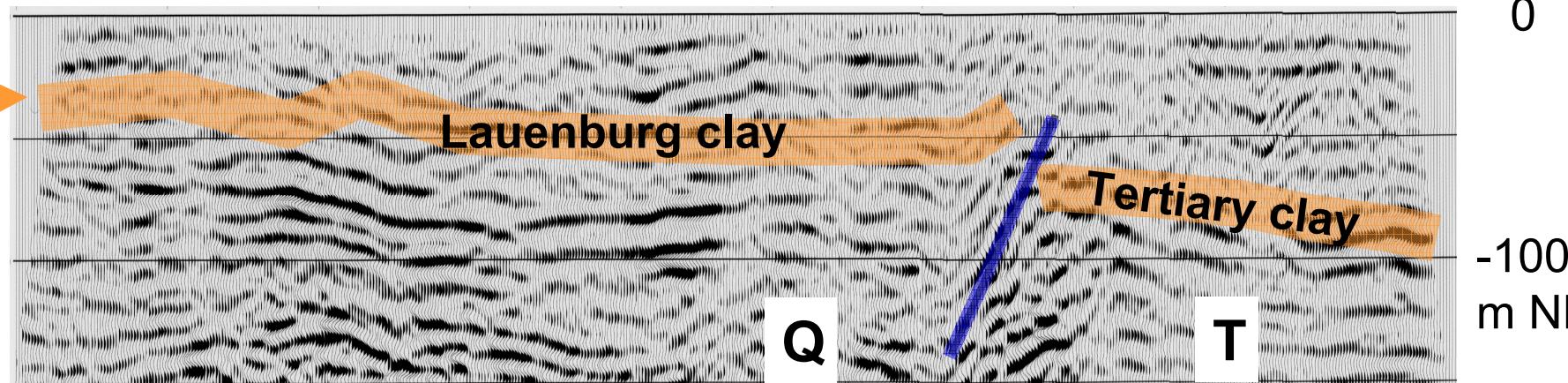
Ellerbeker Rinne



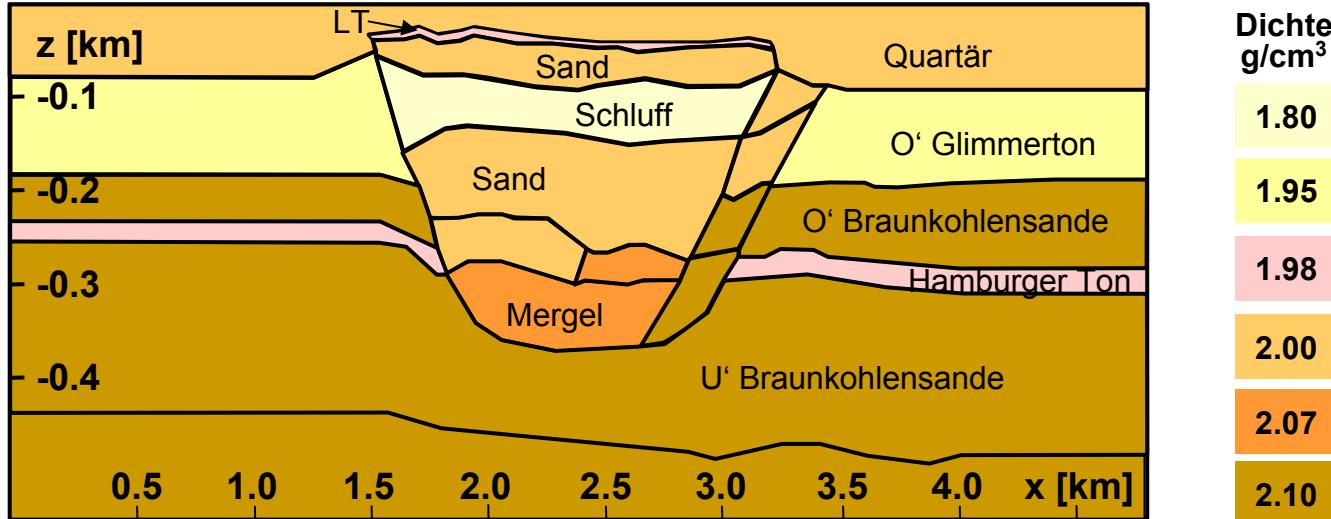
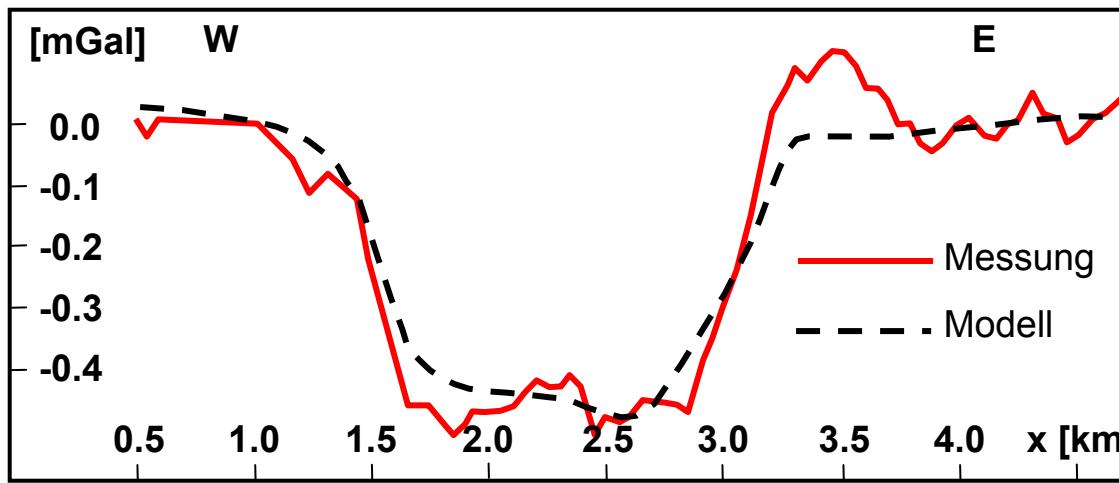
AEM



seismic section



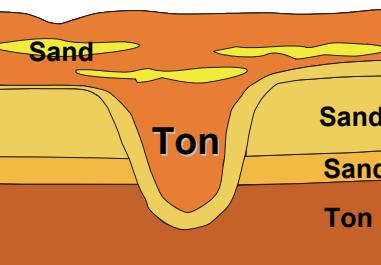
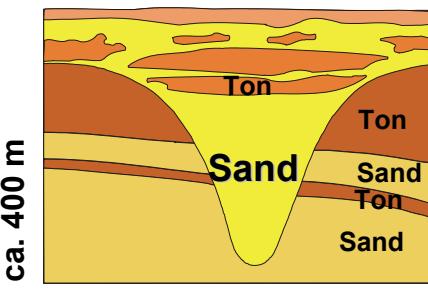
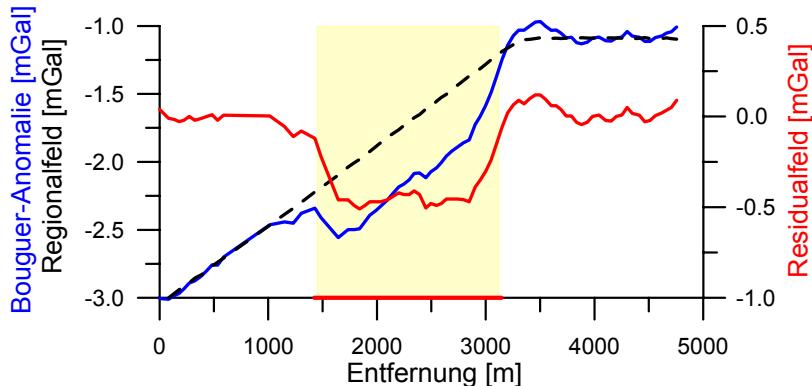
Bouguer Anomalie: Quantitative Interpretation



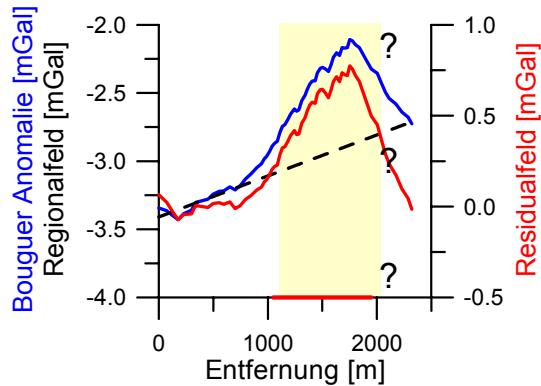
G. Gabrie

buried valleys: Gravity anomalies

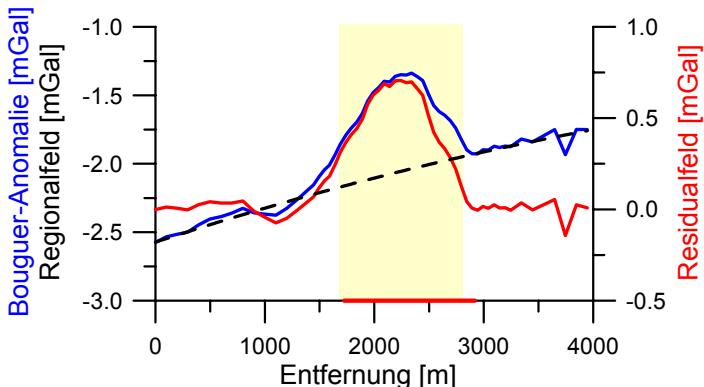
Ellerbek: - 0.5 mGal



Curau: + 0.7 mGal



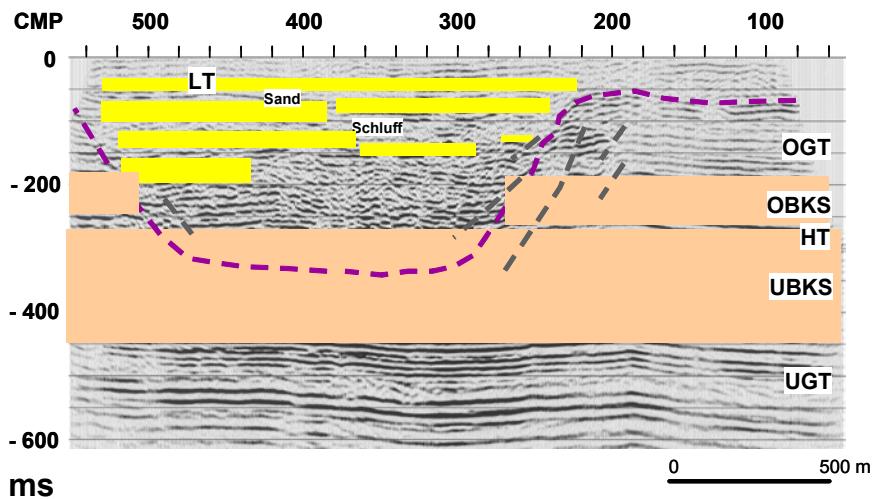
Trave: + 0.7 mGal



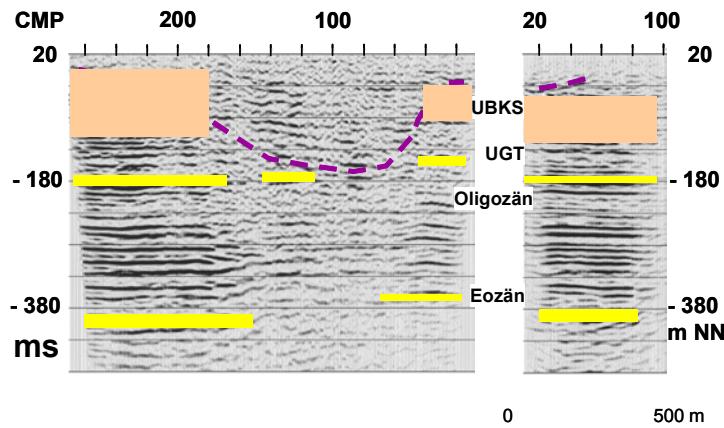
Gabriel, 2003

buried valleys: seismic sections

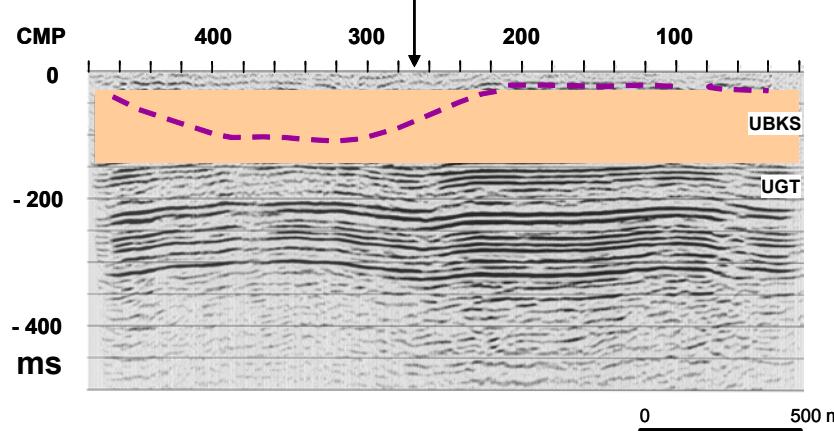
Ellerbeker Rinne



Curauer Rinne

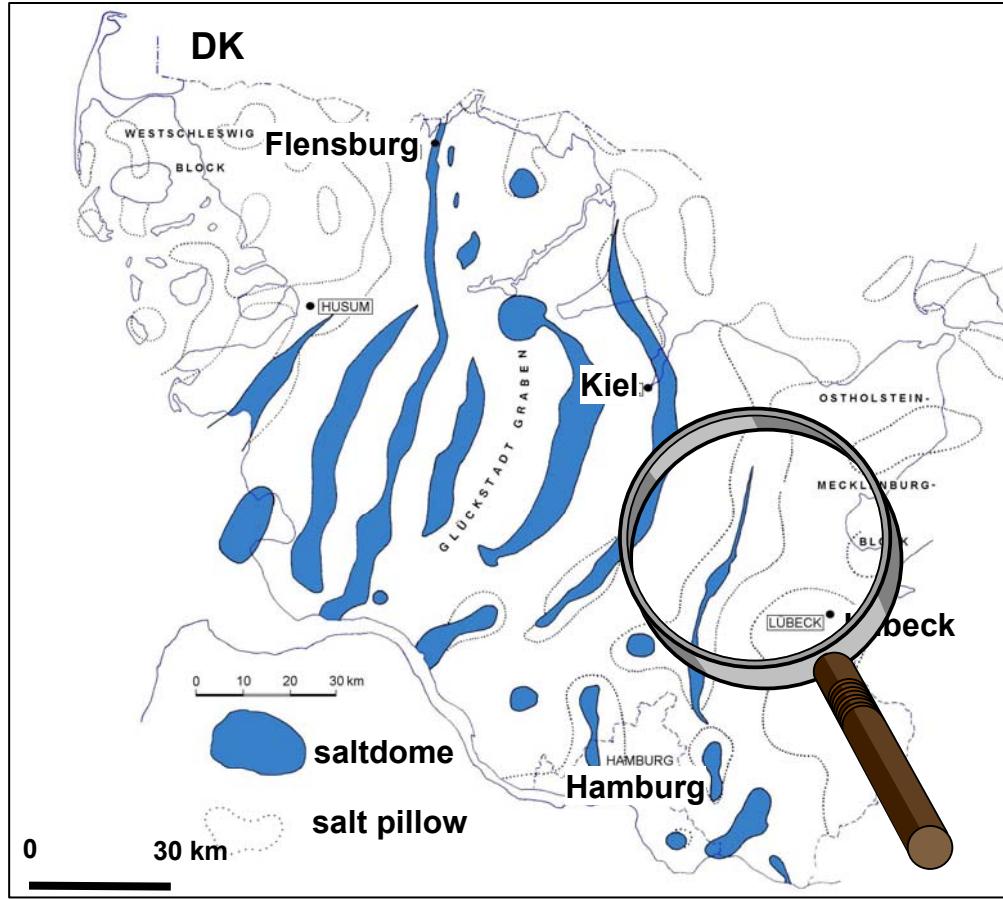


Trave Rinne



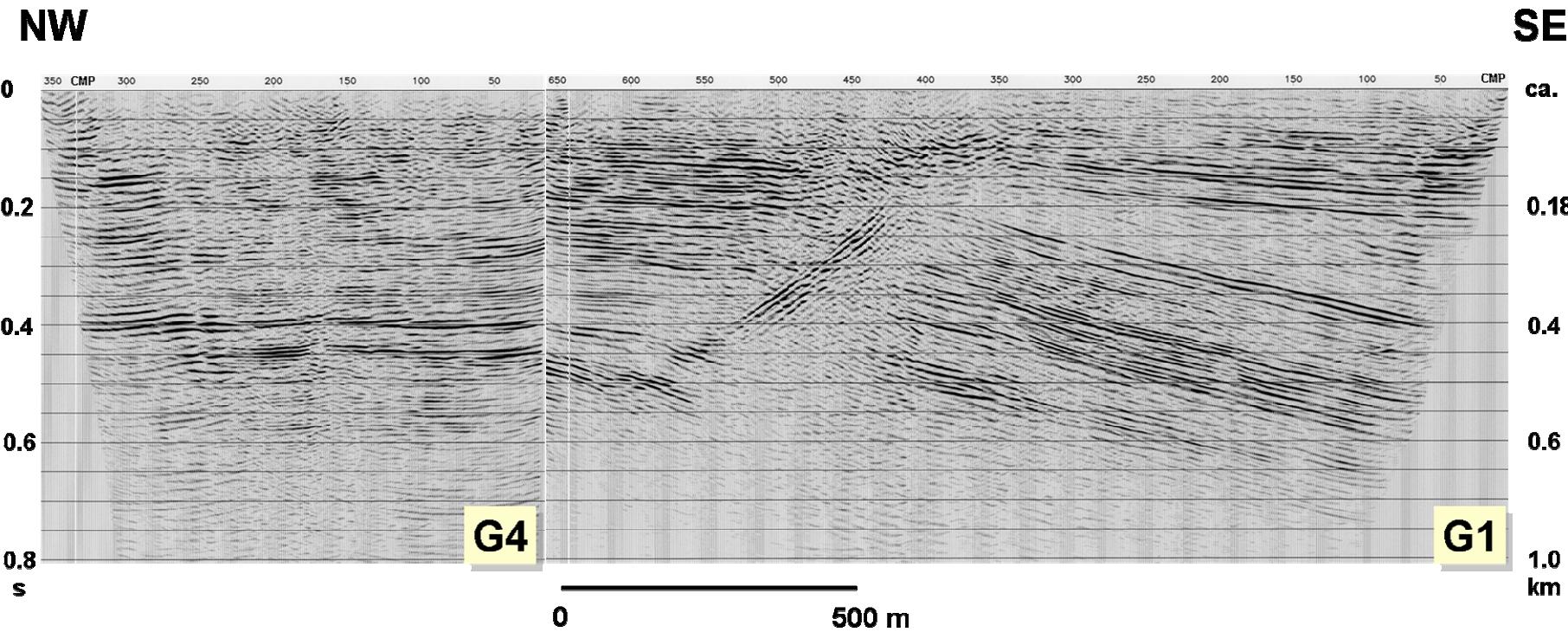
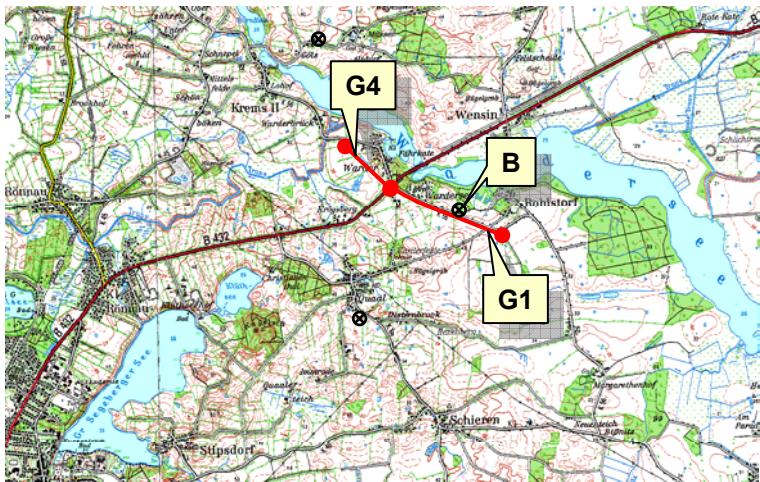
Distribution of salt structures in Schleswig-Holstein

(nach Baldschuhn et al. 2001)

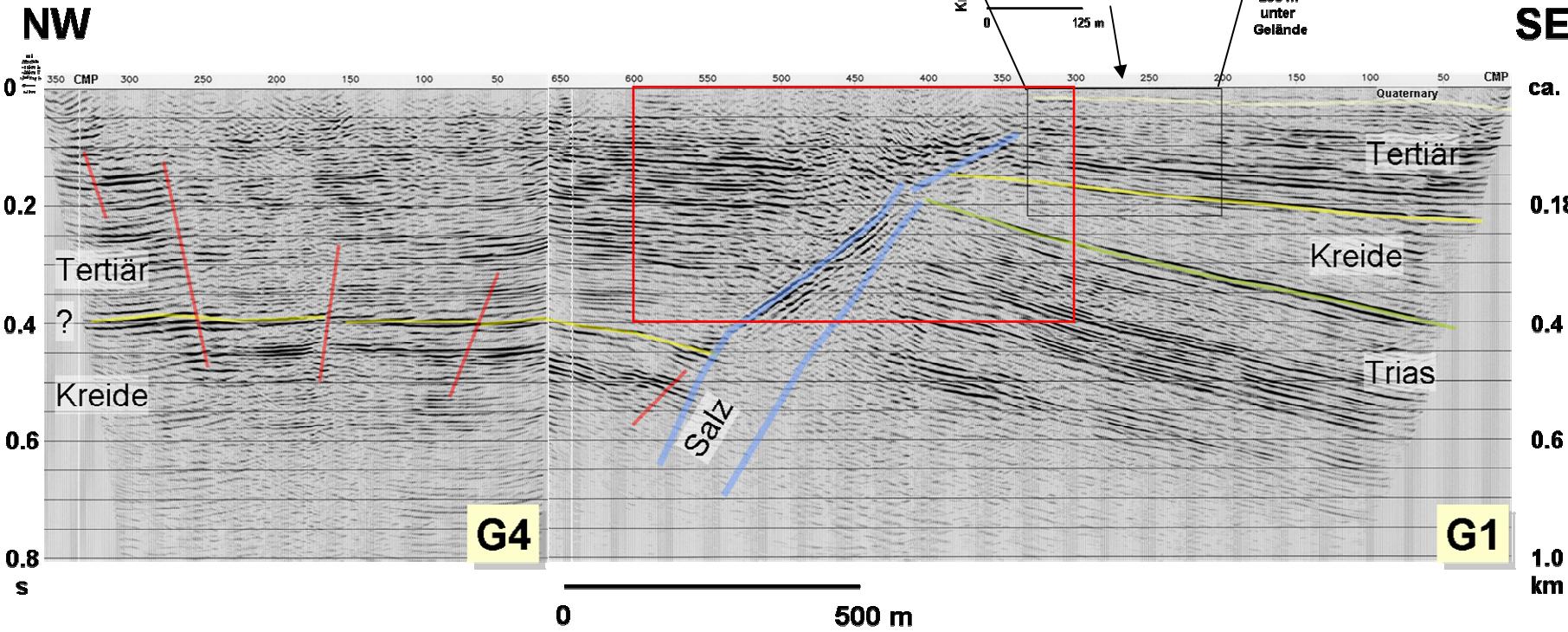


**Saltdome
Bad Segeberg**

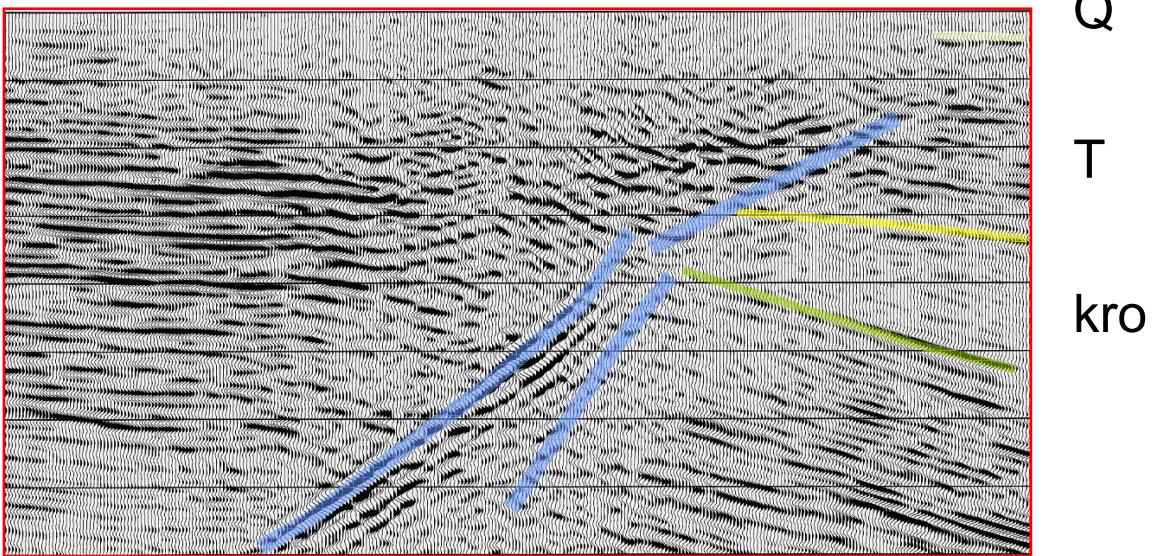
seismic depth section (migrated) Bad Segeberg



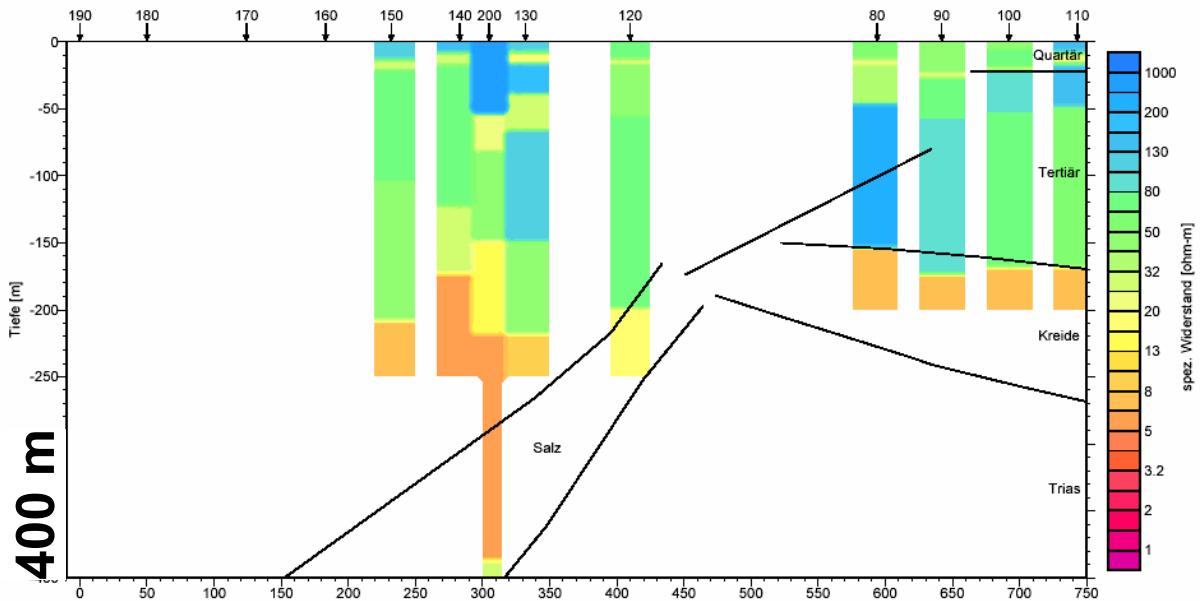
seismic depth section (migrated) Bad Segeberg



seismic section



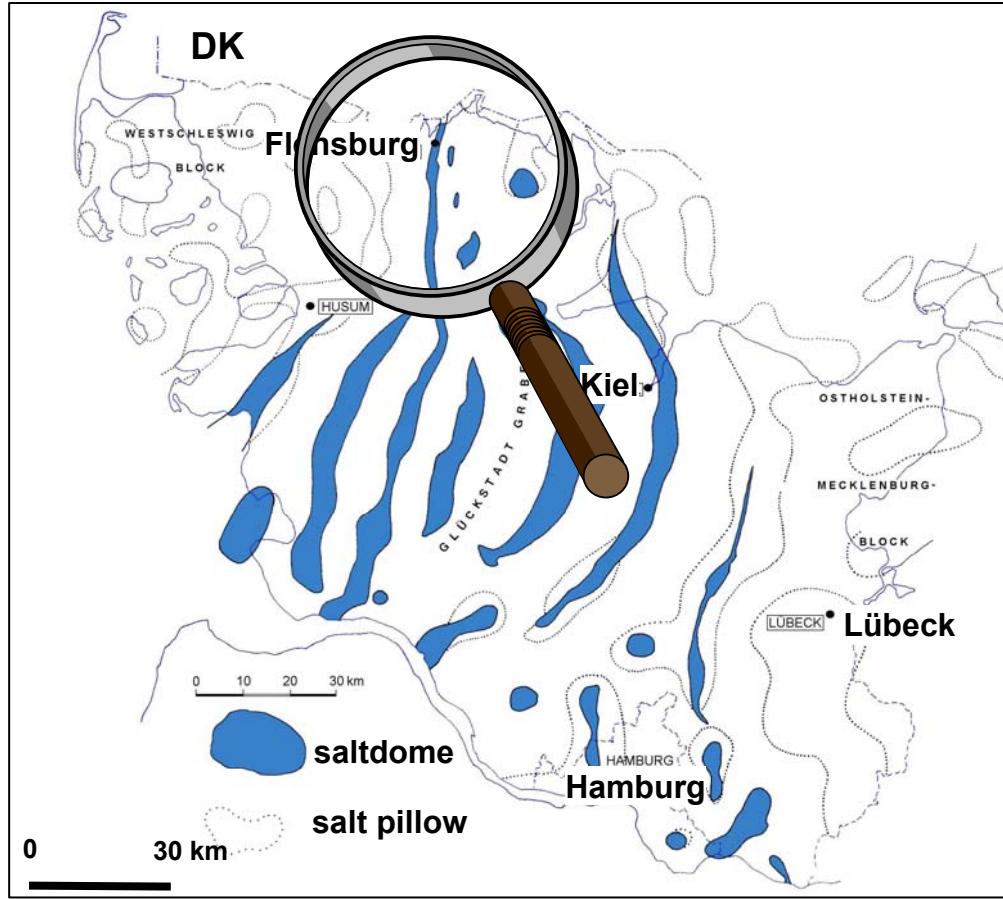
TEM resistivity section



after Stadtler, BGR

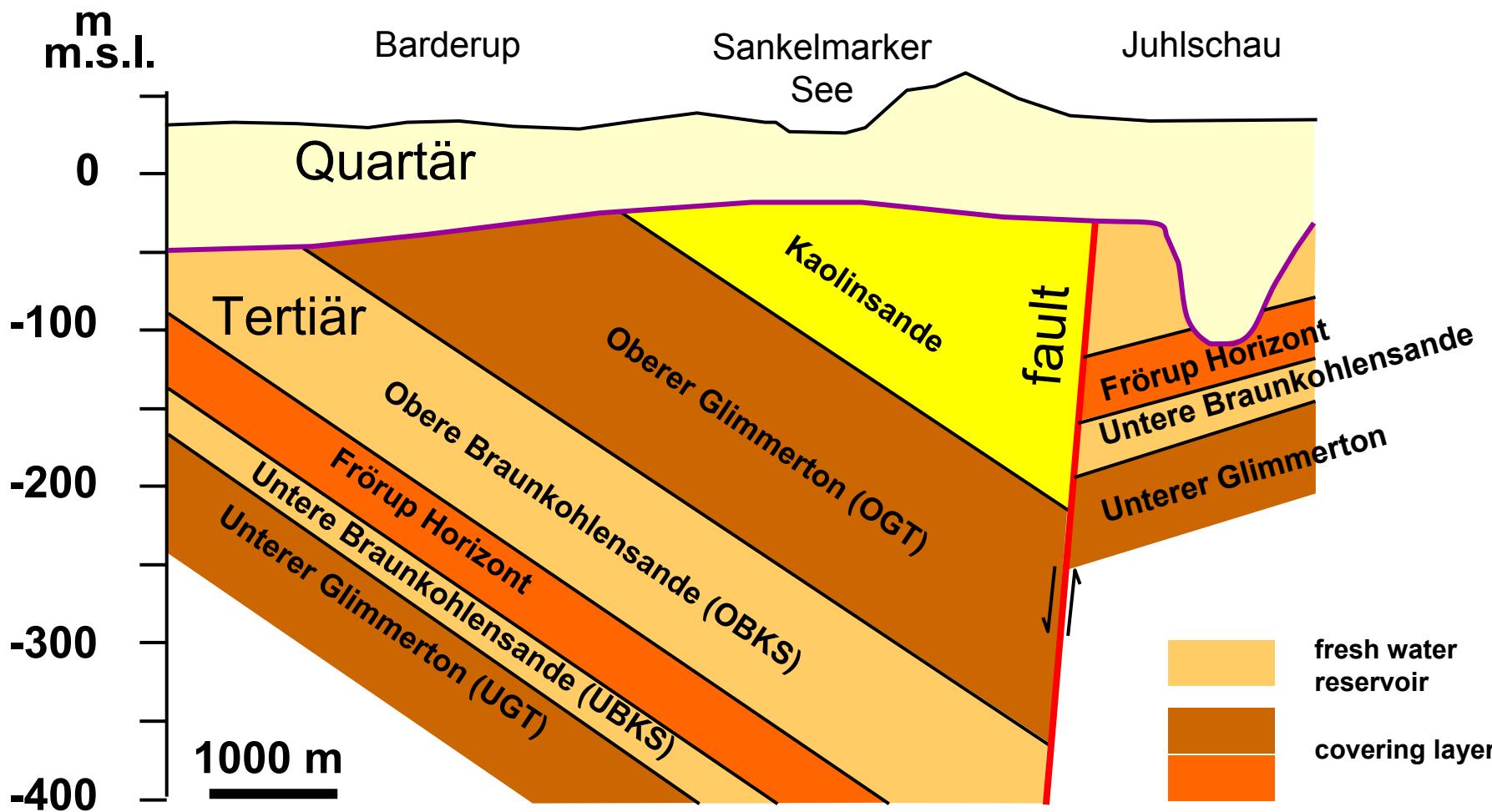
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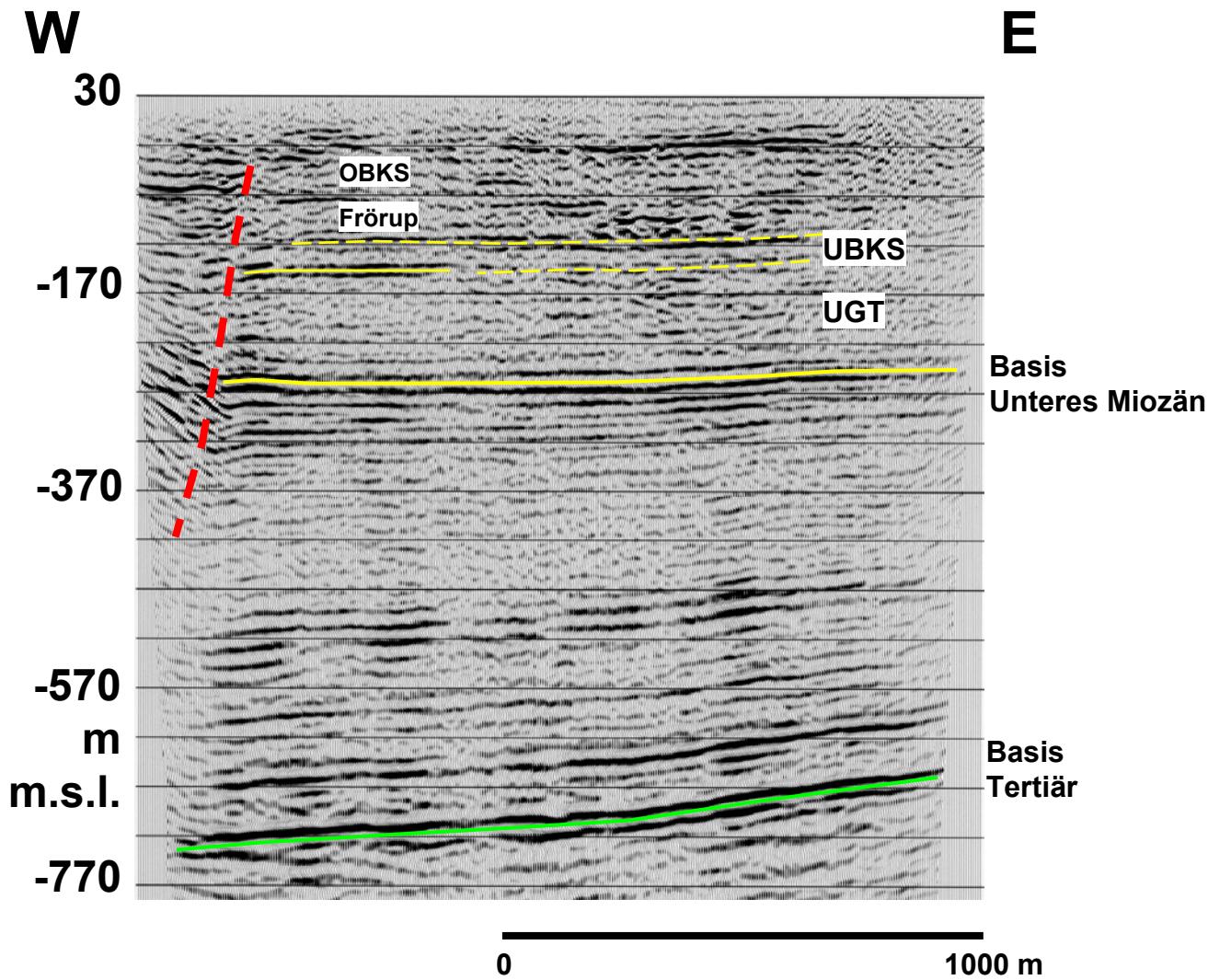


fault zone
Flensburg-Sieverstedt

Geologic model Flensburg-Sieverstedt fault



seismic depth section (migrated)



Gravity (after Stadtler, BGR)

W

E

mGal

[mGal]

7

6

0

Bouguer Anomaly

calculated
measured

Gravity: dotted=calculated, solid=measured
Calculated anomaly shifted!

G1

3000

4000

x [m]

-1200
m
Tiefe

z [m]

Quaternary
and
Tertiary

2.00 g/cm³

2.165 g/cm³

Cretaceous

2.165

200

400

600

800

1000

1200

1400

1000

2000

3000

4000

x [m]

Conclusion: aquifers in glacial deposits

- location and layering are well imaged by seismic reflection methods (e.g. down to 800 m depth)
- combination with VSP and borehole logging enables the understanding of reflections and is a key to geophysical and lithological parameters (hydraulic properties)
- combination with electromagnetic methods (AEM, TEM) turns out to be a good tool for delineation and mapping buried valley aquifers; also key for hydraulic properties (max. 200 m depth penetration)
- gravity anomalies complement and strengthen interpretations (e.g. down to 800 m)

