Hydrogeophysical Characterisation of the Cuxhavener Rinne

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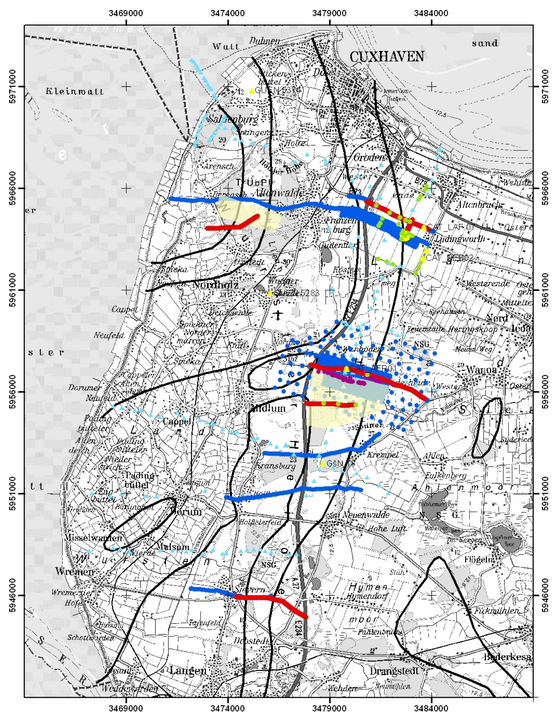
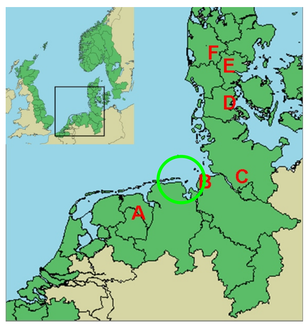
Interreg North Sea Region

Location map



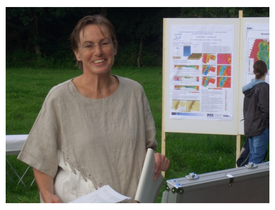
Legend: Reflection seismic (—), Gravimetry (●), SkyTEM (▬), TEM (●), Vertical electric sounding (▲), CPT (●), Well logging (▲).

North sea region



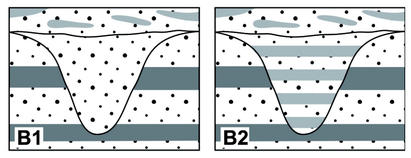
The Cuxhavener Rinne is part of the BurVal project pilot area B.

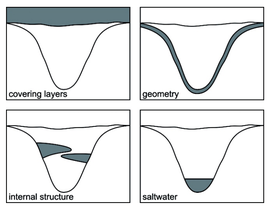
Authors



Context

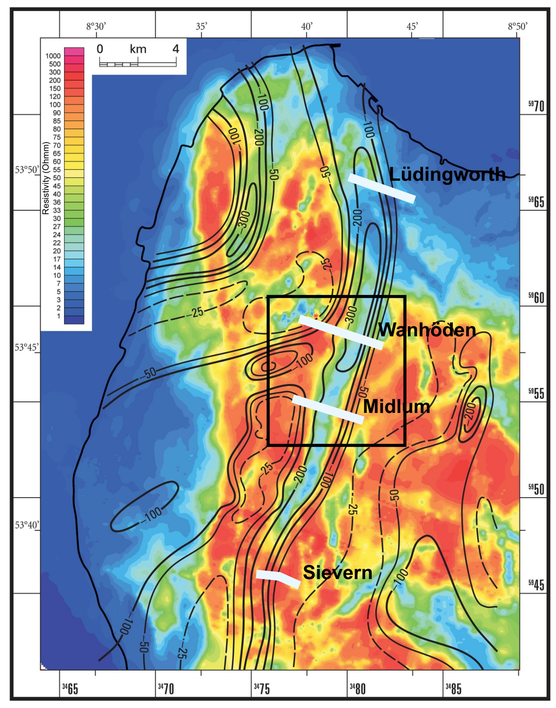
- ❄Tertiary: sand/clay (B)
- ❄Quaternary fill: mainly sand/clay (Type 2), sandy fill in the south (Type 1)
- ❄Quaternary cover: mainly sand, clay, silt and till possible





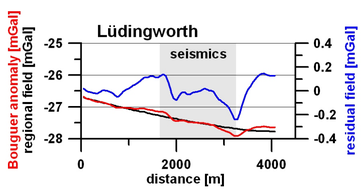
- ❄Mapping: HEM, SkyTEM (Univ. Aarhus), Gravimetry
- ❄Geometry: seismics
- ❄Internal structure: seismics, HEM, SkyTEM
- ❄Covering layers: Well logging, VSP, CPT
- ❄Vulnerability: HEM, SkyTEM
- ❄Saltwater: HEM (Well looging not shown)

HEM apparent resistivity map



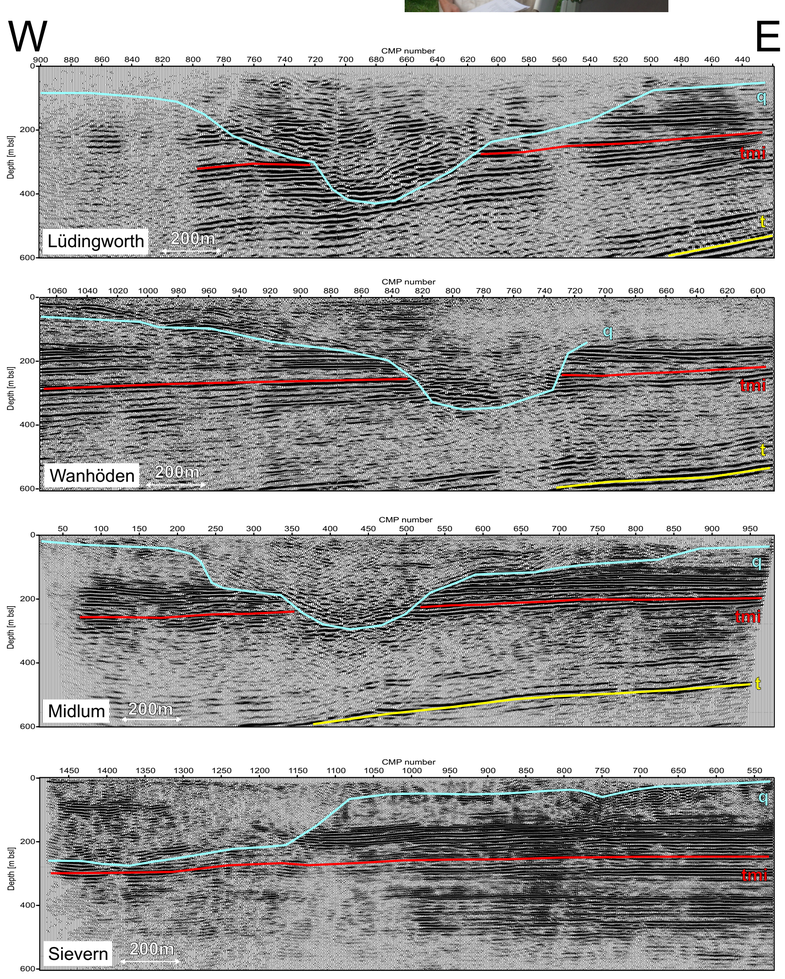
Apparent resistivity map (f=1840 Hz) derived from helicopter electro-magnetic survey (HEM) after Siemon et al. (2004). The contour lines show the base of Quaternary in meter b.s.l. (Kuster and Meyer, 1995). The seismic profiles are marked in white and the SkyTEM survey by a black rectangle.

Gravimetry



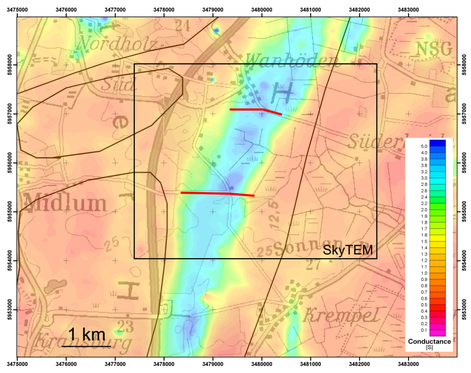
The change in the valley fill is reflected by the Bouguer anomaly. Positive, in general, it is over compensatd by a near-surfec clay (Lüdingworth) or a moor (Wanhöden).

Reflection seismics

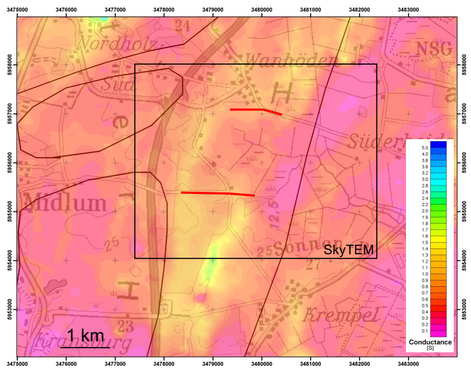


Seismic profiles across the Cuxhavener Rinne from north (Lüdingworth) to south (Sievern). The coloured lones show the interpreted base of Tertiary (—), the base of Miocene (—) and the base of Quaternary (—). Note the flattening of the buried valley and the varying shape of its shoulders.

Vulnerability

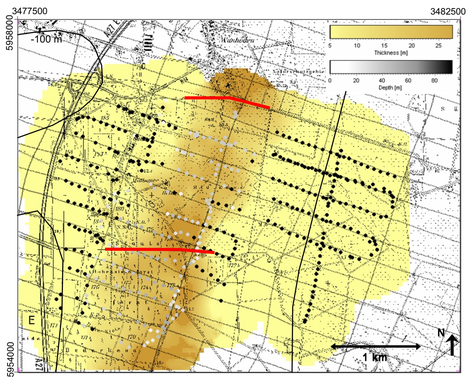


HEM conductance map for 60 m depth. The protection of the valley is good in the blue area.



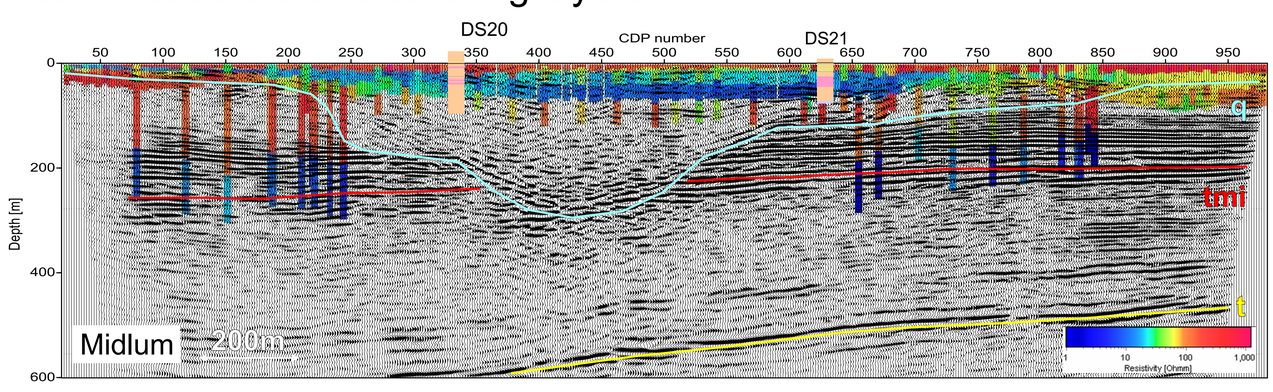
HEM conductance map for 25 m depth. Only thin clay layers are found above the buried valley (orange colours).

Depth and thickness of the Lauenburger clay



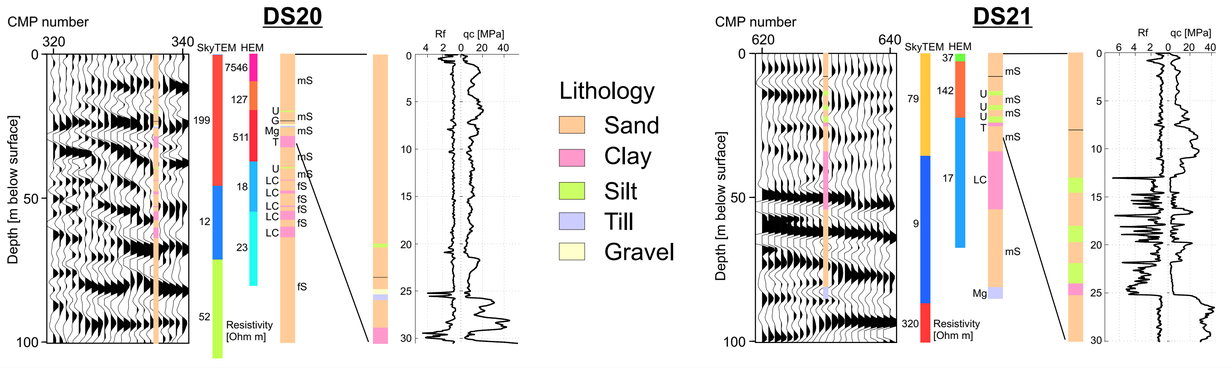
Based on SkyTEM data (Aarhus University) the Lauenburger clay is roughly 15 - 30 m thick (brownish colours) and 40 - 60 m deep in the Midlum/Wanhöden area. The red lines mark the buried valley in the seismic lines. The black lines denote the 100 m depth contour after Kuster and Meyer (1995).

Internal structure and covering layers



Above: At Midlum the covering clay layer shows up clearly in the SkyTEM data (blue). It is marked in the seismic section by a strong reflector (e.g. DS21). The valley is narrower than expected from the Quaternary base map. At the eastern valley rim the clay distribution in the EM data helped to identify the flank in the seismic section.

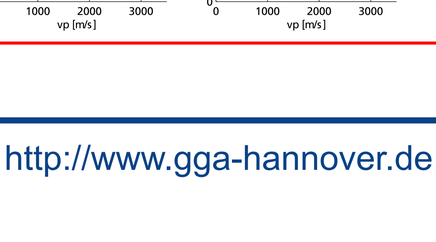
Below: Shallower and thinner clay/silt layers are easily seen by the CPT.



Seismic velocities Cuxhavener and Ellerbeker Rinne

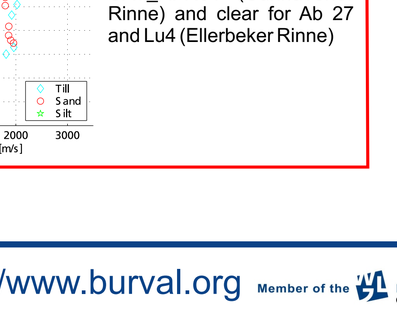
VPS measurements have been conducted in the project pilot areas Cuxhavener Rinne (B) and Ellerbeker Rinne (C). Each velocity value is assigned to the corresponding lithology (sand, silt, clay or till) at that depth in the borehole.

All Data



Vs in general lower in Cuxhaven

Sand



- ❄General: Wide Vp and Vs range
- ❄Type I: Vp increases (400-1500 m/s), Vs ranges around 250 m/s. Interpretation: Increasing water content
- ❄Type II: Vp ranges around 1800 m/s, Vs increases up to 600 m/s. Interpretation: Influence of compaction
- ❄Type I and II easier to recognise in the Ellerbeker Rinne

Clay

General: Narrow Vp and Vs range

Borehole outside valley

Evolving path clear for both the LUD1A (Cuxhavener Rinne) and Ab 1/74 (Ellerbeker Rinne)

Borehole in valley

Evolving path chaotic for CAT_AFR01 (Cuxhavener Rinne) and clear for Ab 27 and Lu4 (Ellerbeker Rinne)

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