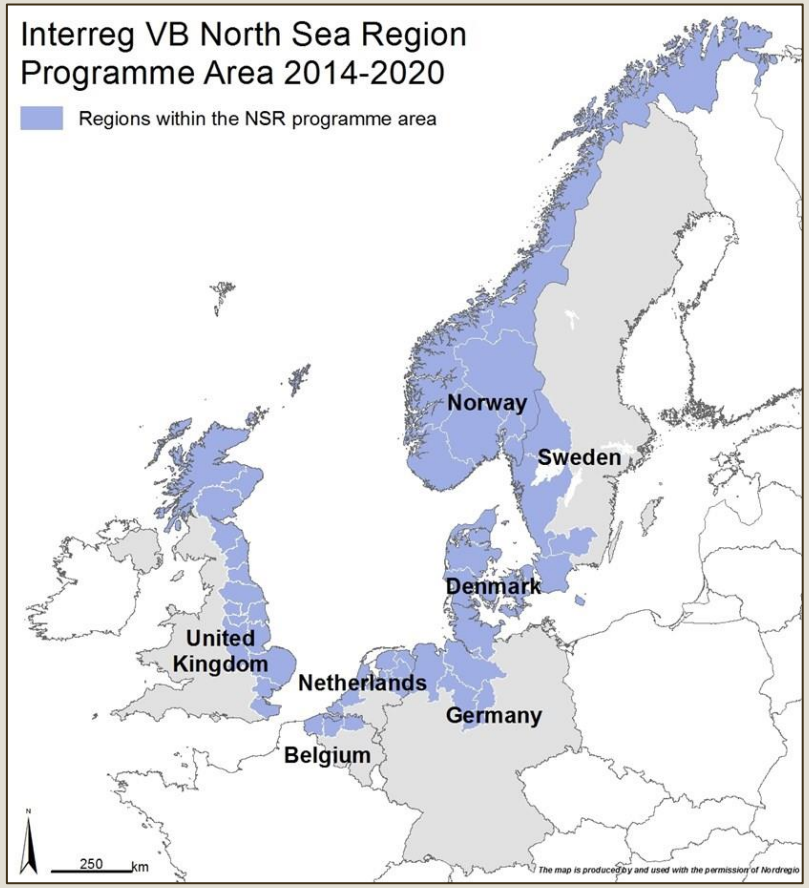
Detailtolkning og kortlægning med tTEM – eksempler fra TOPSOIL og andre projekter

Flemming Jørgensen, Region Midtjylland

ATV Jord og Grundvand, Vingsted 6. marts 2019

TOPSOIL



- Projektperiode: dec 2015 - feb 2020
- Budget: 55,5 mio kr.

- Klimaændringernes påvirkning i de øvre jordlag
- Metodeudvikling til kortlægning og modellering af de øvre jordlag
- Klimatilpasning
- Erfaringsudveksling og interessent-involvering

24 partnere

Belgium and The Netherlands
- Flanders Environment Agency, VMM
- Hunze en Aa's regional water authority, WBHA
- Province of Drenthe, PD
- Waterschap Noorderzijlvest, WB Noorderzijlvest

Germany
- Umbrella waterboard for Irrigation in the county of Uelzen, UWIU
- Chamber of Agriculture Lower Saxony, CALS
- Federal Institute for Geosciences and Natural Resources, BGR
- University Bremen Geological Survey of Bremen, GDfB
- State Authority for Mining, Energy and Geology, LBEG
- Leibniz Institute for Applied Geophysics, LIAG
- Waterboard of Oldenburg, OOWV
- State Agency for Agriculture, Environment and rural Areas Schleswig- Holstein, LLUR

UK
- The Rivers Trust
- Wear Rivers Trust
- Norfolk Rivers Trust
- Essex & Suffolk Rivers Trust
- Northumbrian Water Limited
- Durham University

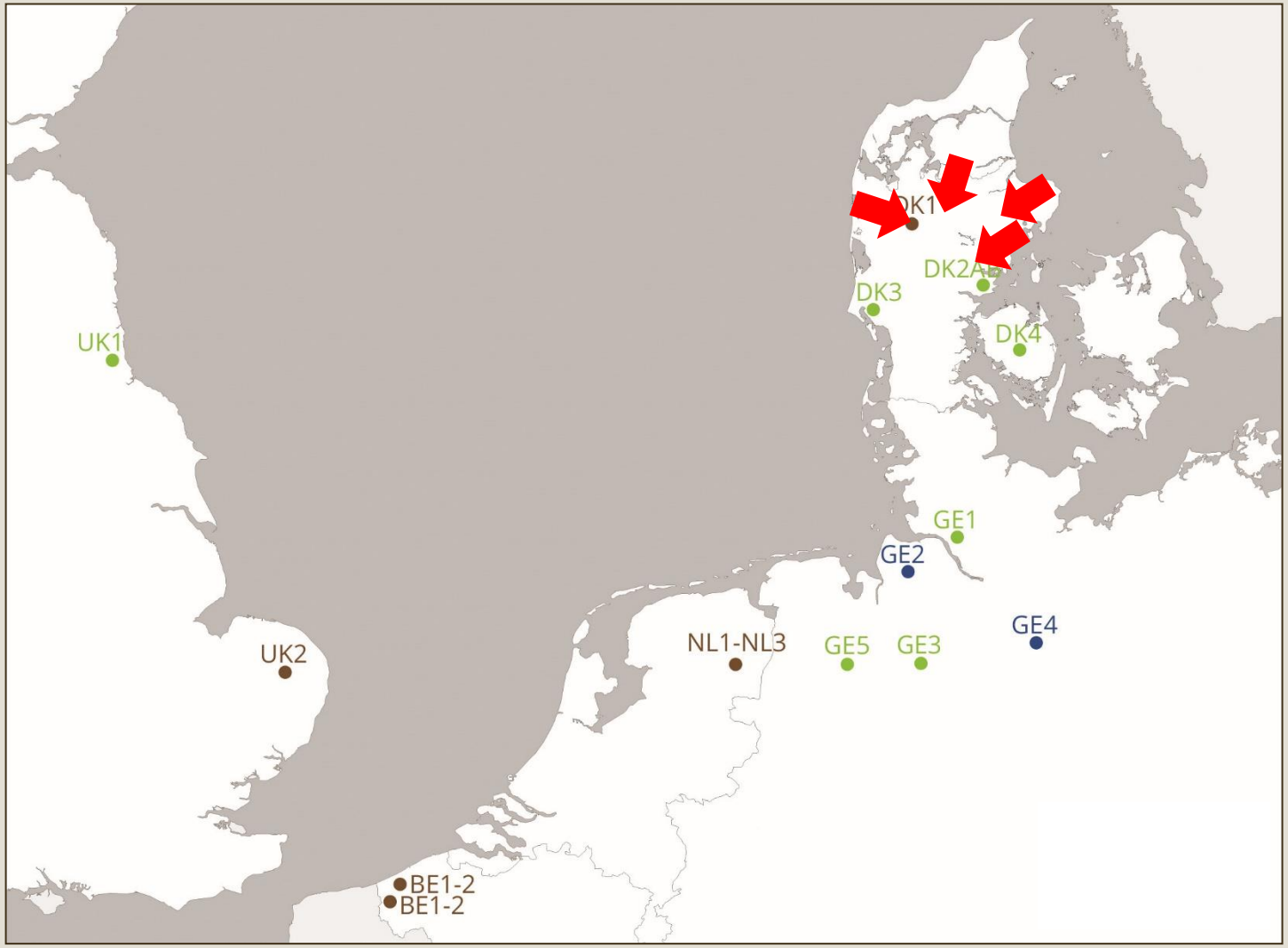
Denmark
- Herning Kommune
- Horsens Kommune
- Region Syddanmark
- GEUS
- Aarhus Universitet
- Region Midtjylland

TOPSOIL

- Sunds
- Lillerupgård
- Trige
- Hauge

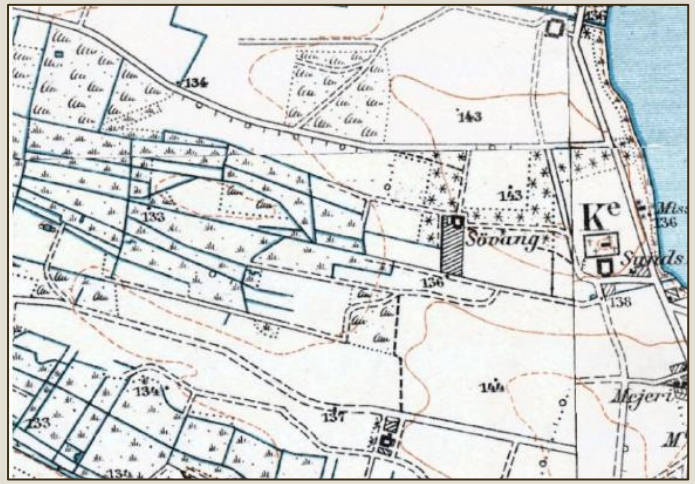
tTEM

16 pilot områder



Sunds

1925:



Nu:

4000 indbyggere i Sunds

- Øget nedbør og igangværende renovation af kloaksystem --> stigende grundvandsstand i byen
- Oversvømmelse af kældre

Sunds

Hydrologisk model

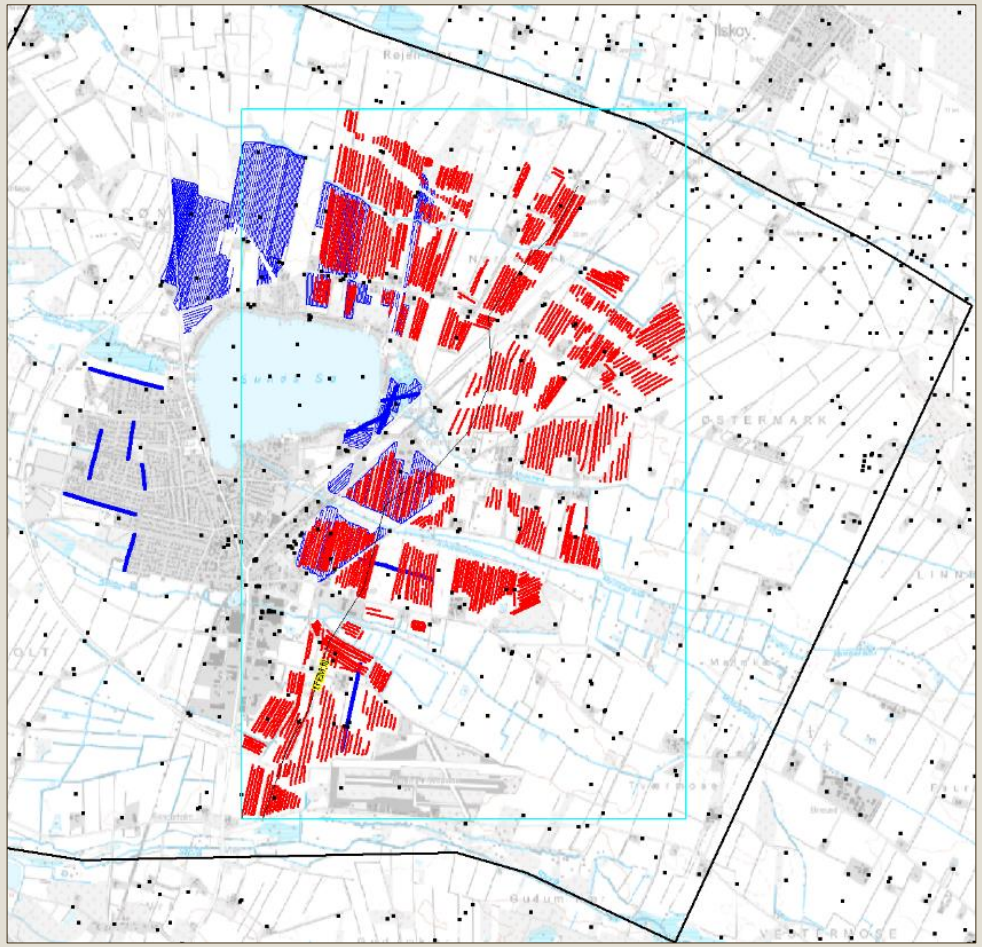
- Opstilling af en højopløselig hydrologisk model (GEUS)
- 25 x 25 m med 10 beregningslag
- Modellen inkluderer urbane elementer (kloaksystem, kældre etc.)
- Modellen bygger på detaljeret geologisk viden

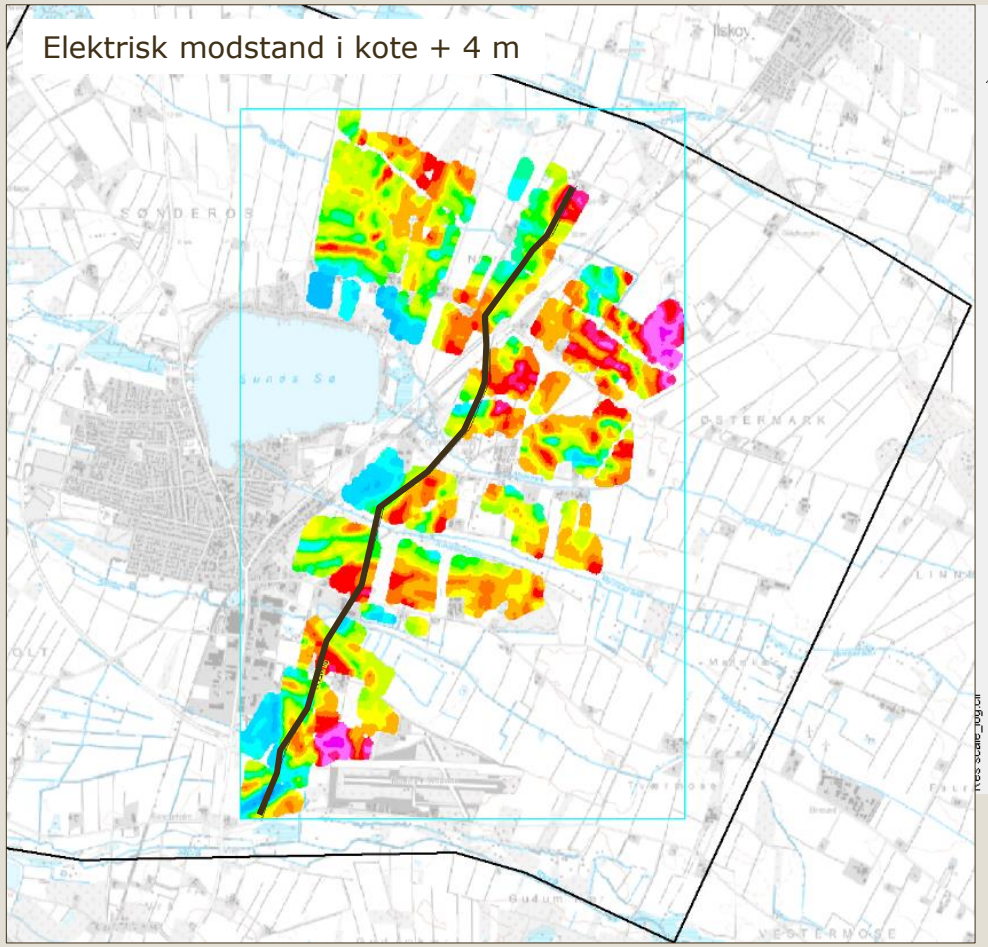
- Følgende scenarier undersøges:
  - Konsekvens af kloaktætningen
  - Konsekvens af lokal nedsivning af regnvand
  - Konsekvens af eventuel reduktion af grundvandsindvinding ved vandværk
  - Effekten af implementering af afværgedræn i byen
  - Effekten af en forøgelse af befæstningsgrad
  - Effekten af skovplantning
  - Effekten af klimaforandringer svarende til perioderne 2041-2060 og 2081-2100
- Mængden af overskudsvand beregnes

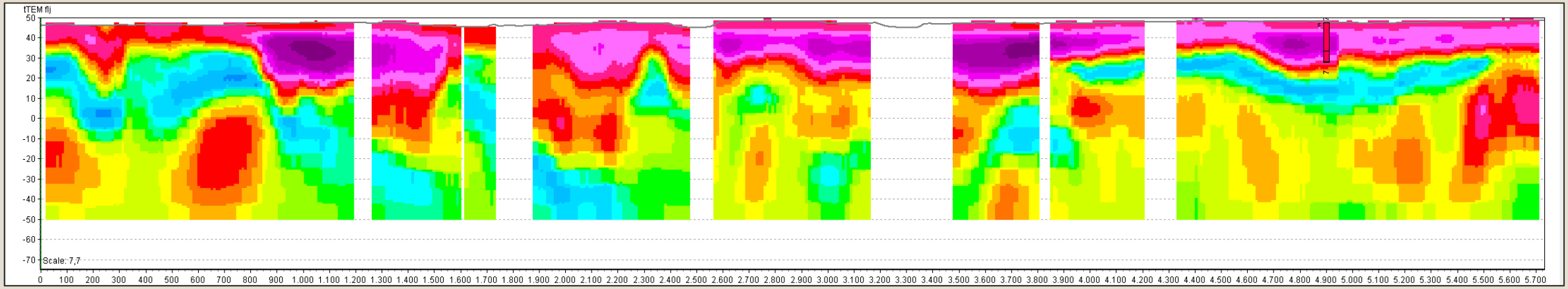
Sunds

tTEM resultater

tTEM
GCM/DualEM
ERT

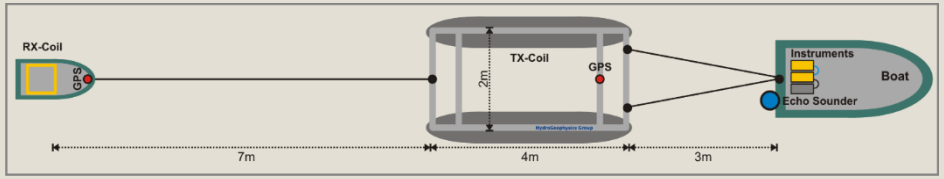






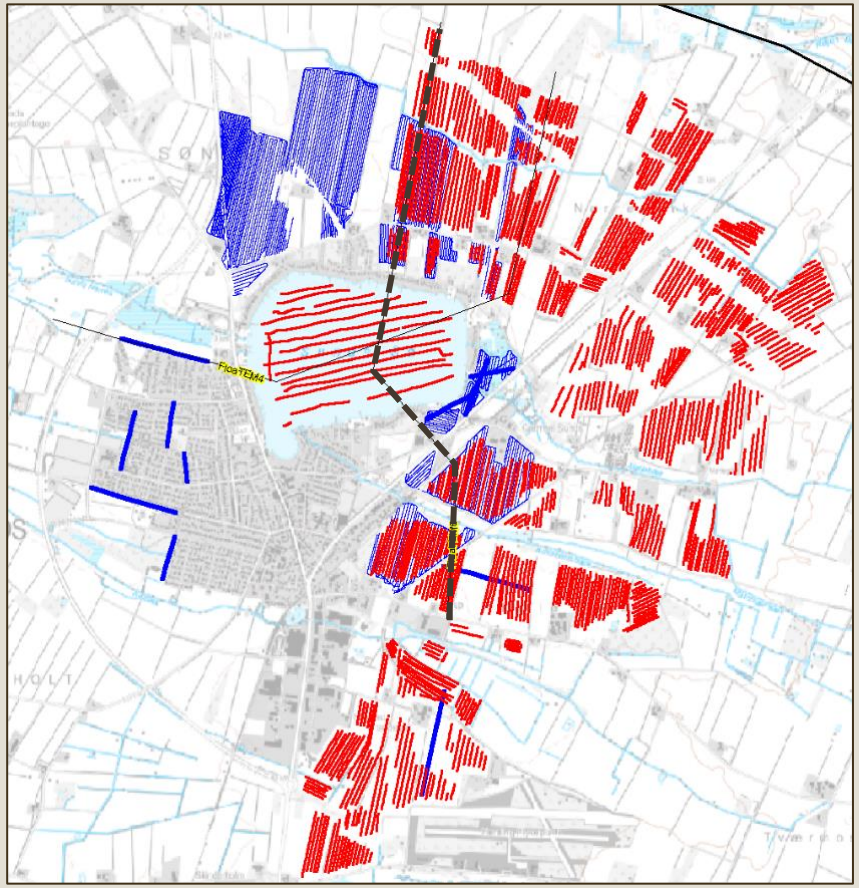
Sunds Pilotområde

FloaTEM på Sunds Sø



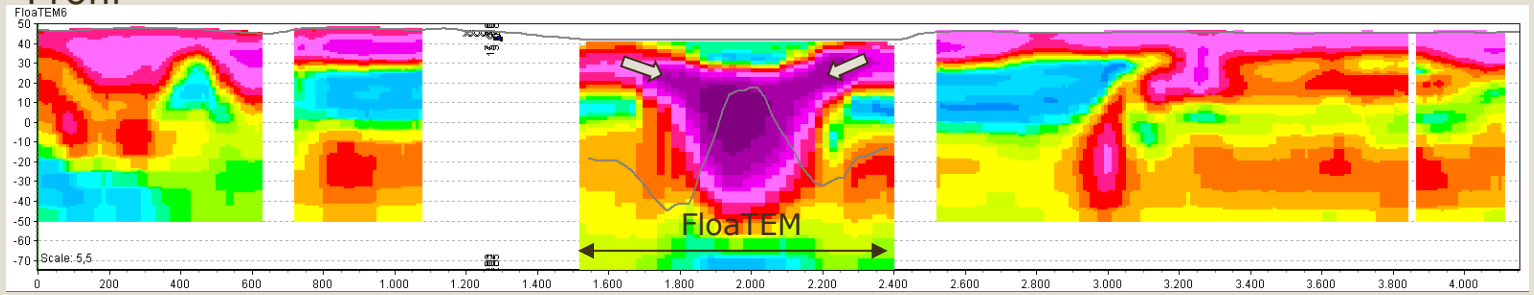
Aarhus Universitet

Profil



tTEM
GCM/DualEM
ERT

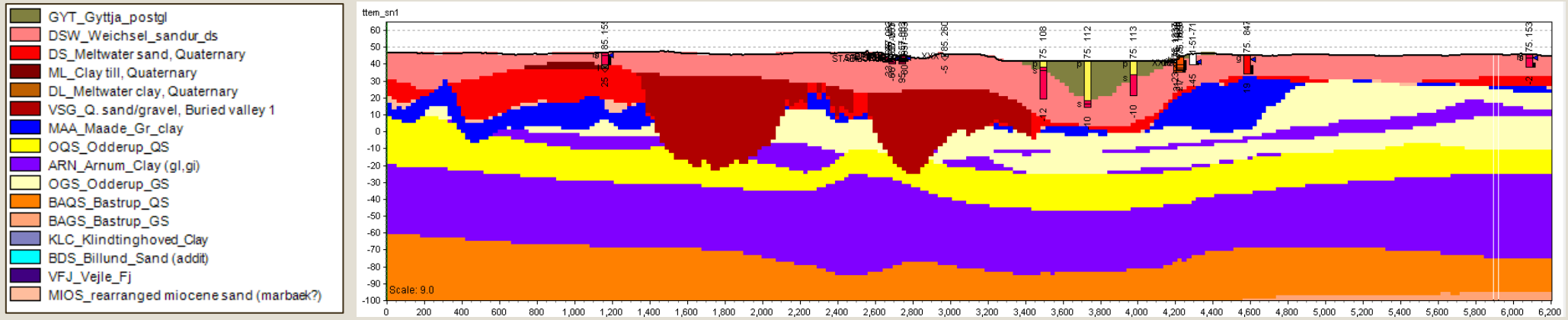
Profil



Sunds

Geologisk model

Anders Juhl Kallesøe, GEUS



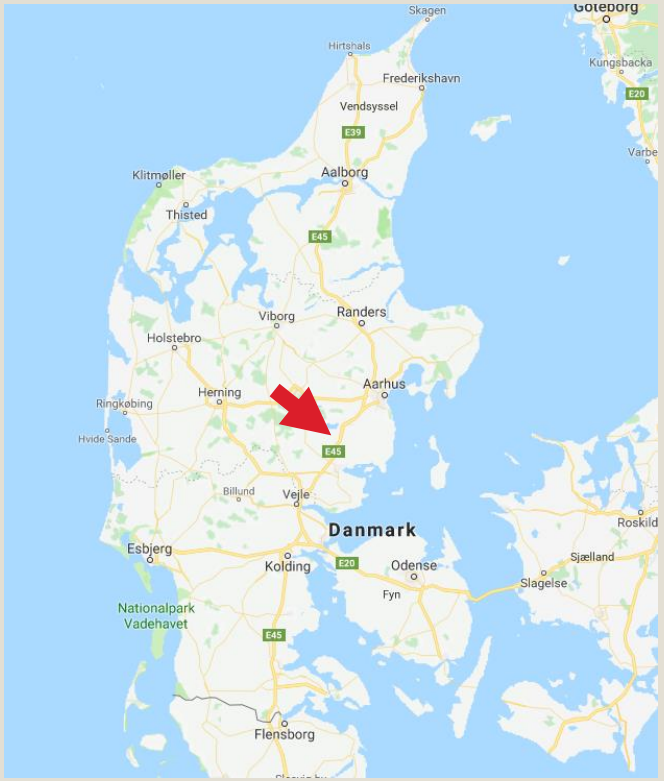
- 3D voxel model med en opløsning på 25 x 25 x 2 m
- 16 lithologiske klasser

Nogle resultater:

- Marint tertiært ler (Måde Ler) har en afgørende indflydelse på det hydrauliske system
- Der ser ud til at være hydraulisk kontakt mellem sø og omgivelser
- Geofysiske data nødvendige for at få en tilstrækkelig forståelse og opløsning af det komplekse geologiske miljø

Lillerupgård

- **tTEM kortlægning**
- GCM kortlægning
- Magnetometer kortlægning
- **Boringer**
- (Geologisk model)
- (Grundvandsmodel)

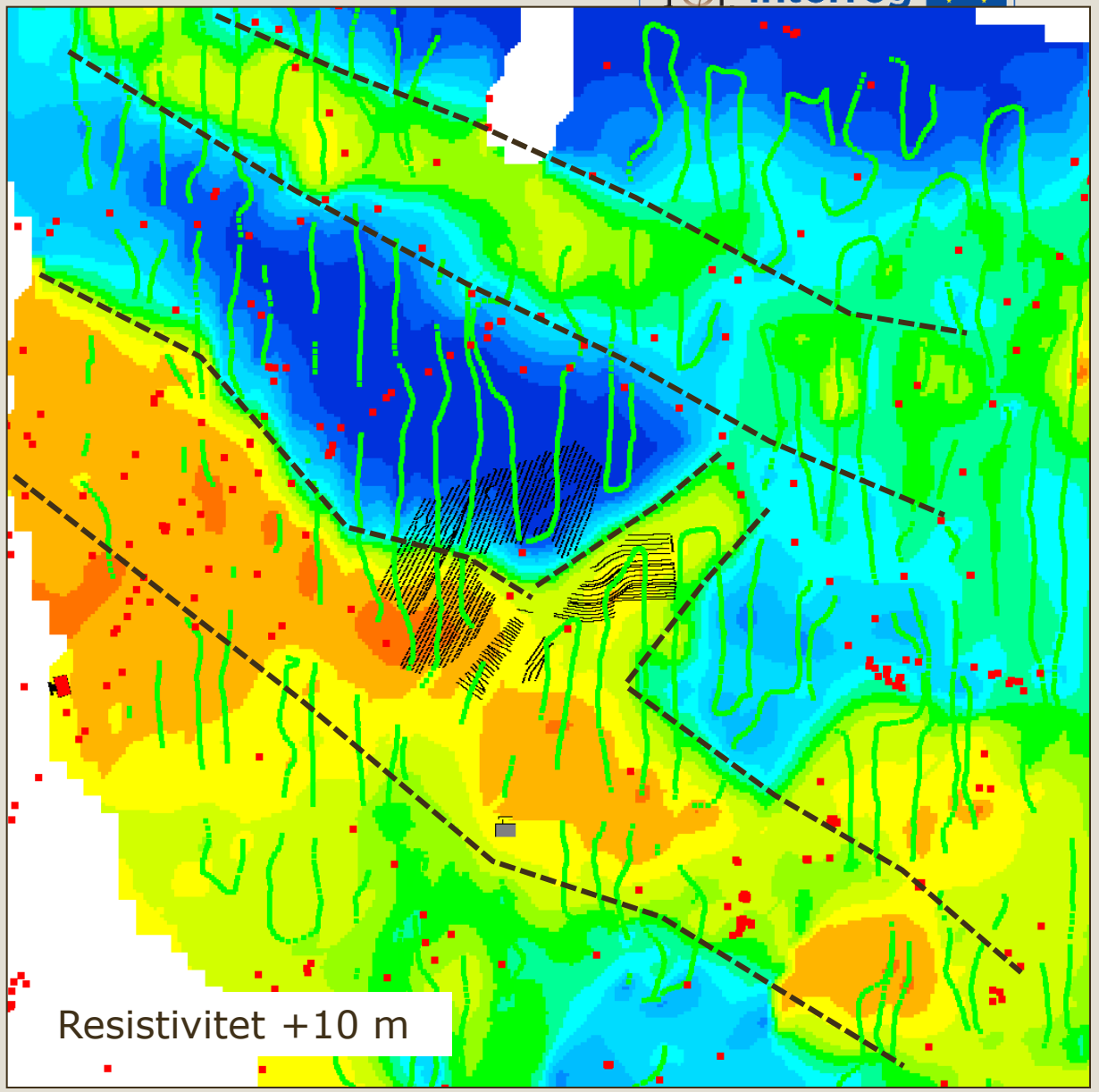


Lillerupgård

SkyTEM data

- SkyTEM (grøn)
- tTEM (sort), ca. 200 ha

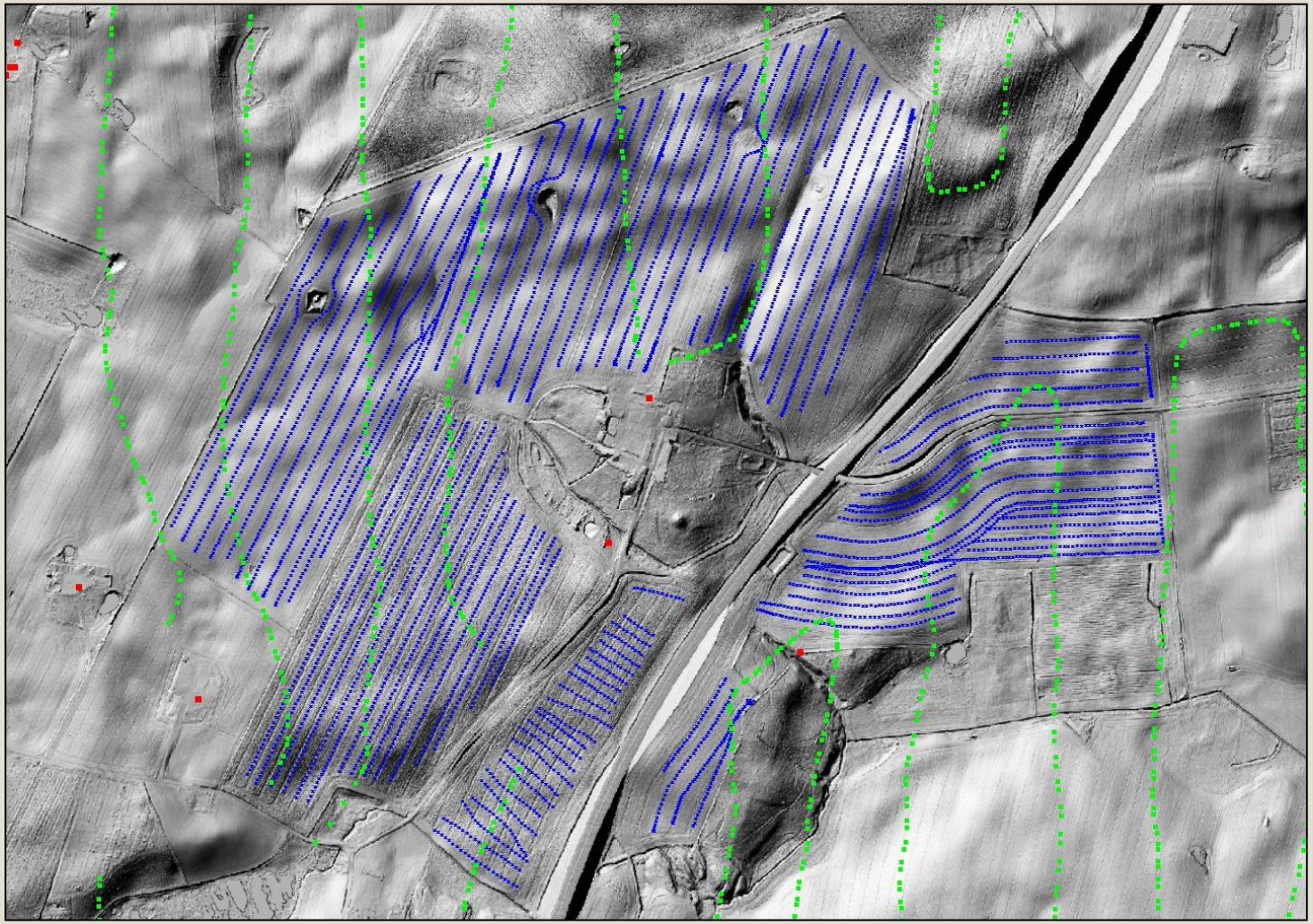
- Begravede dale



Lillerupgård

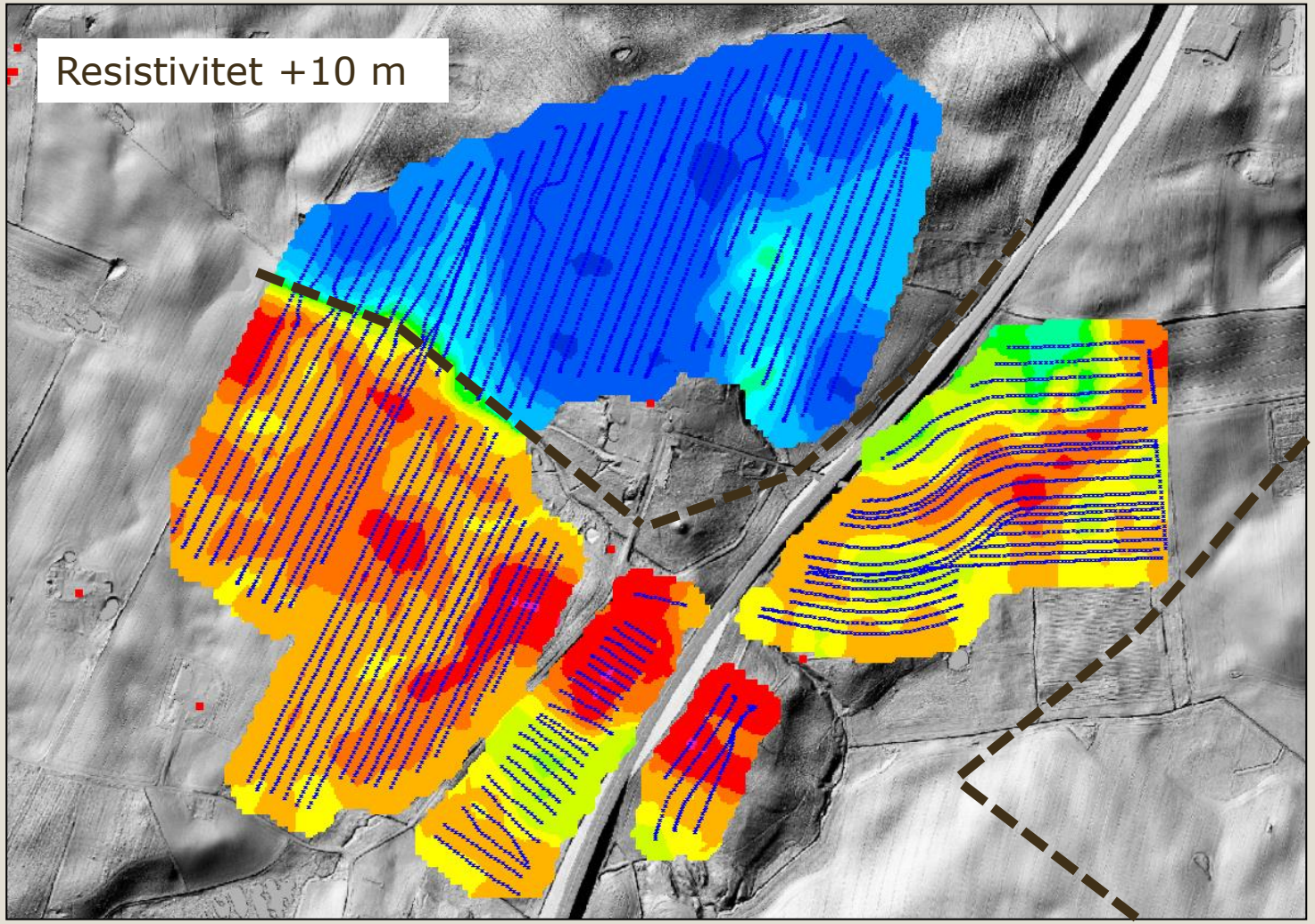
tTEM data

- SkyTEM (grøn)
- tTEM (sort), ca. 200 ha



Lillerupgård

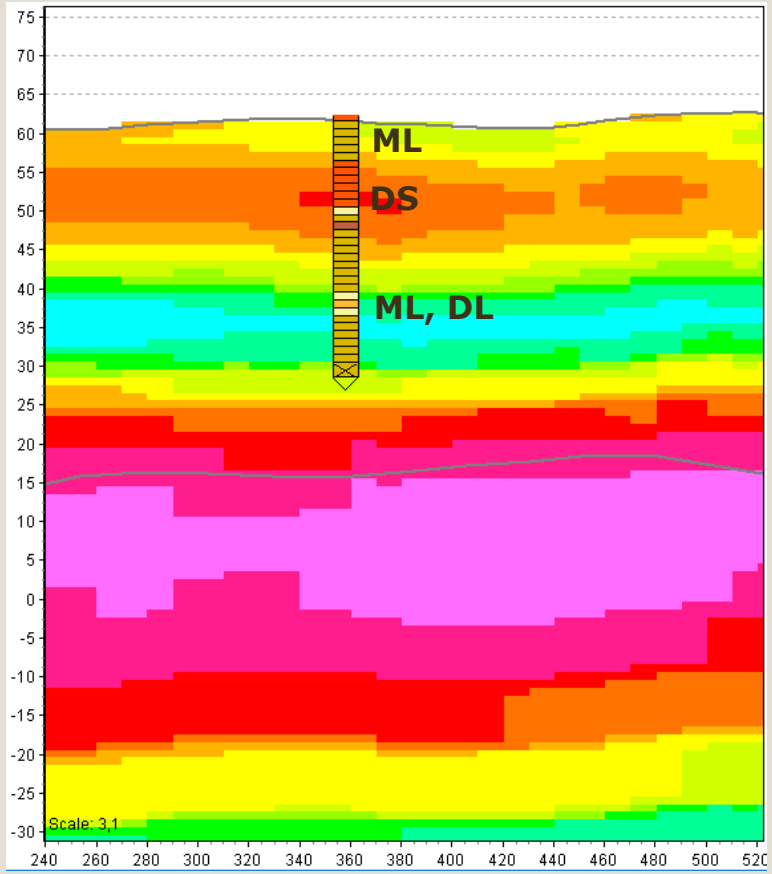
tTEM data

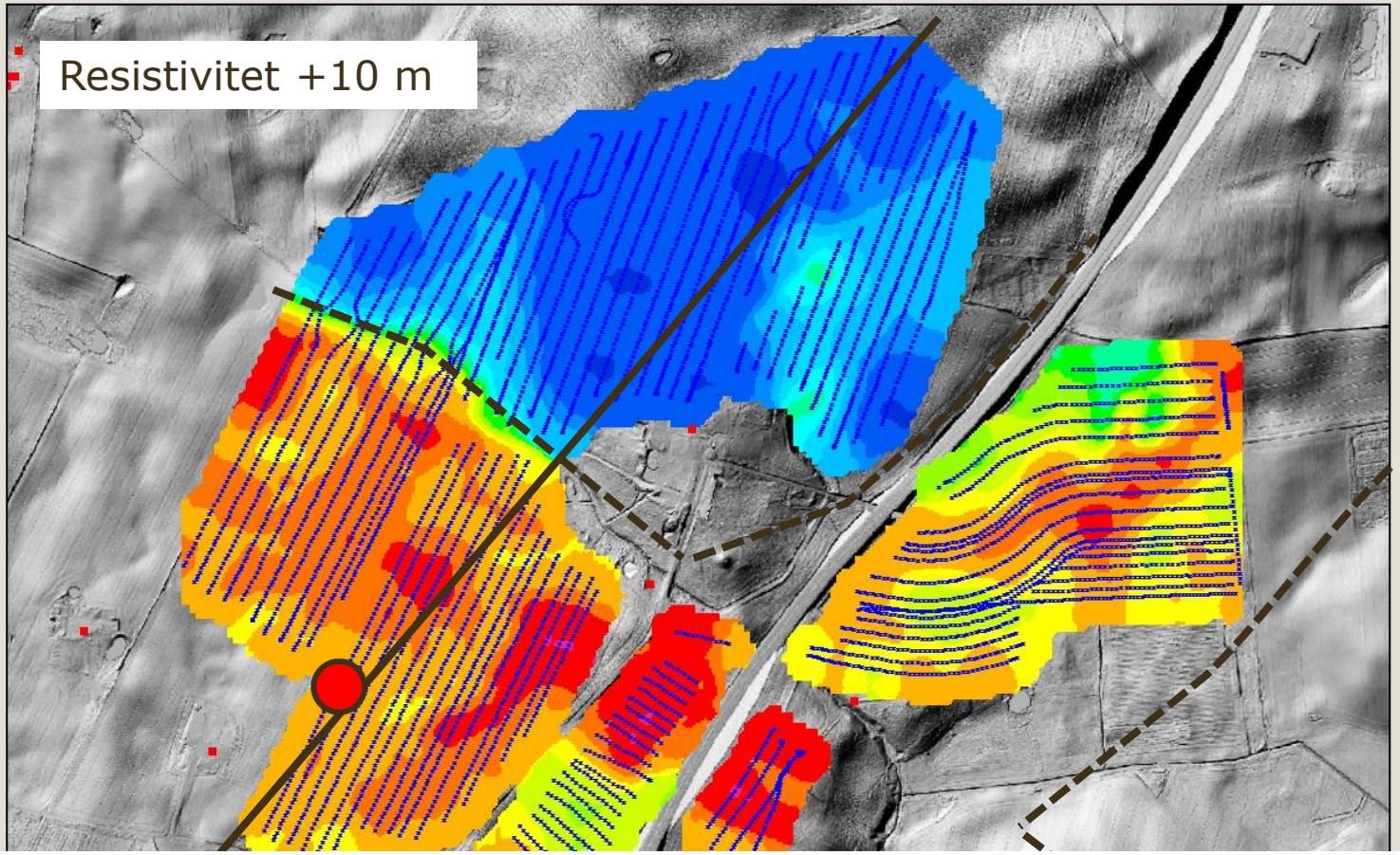


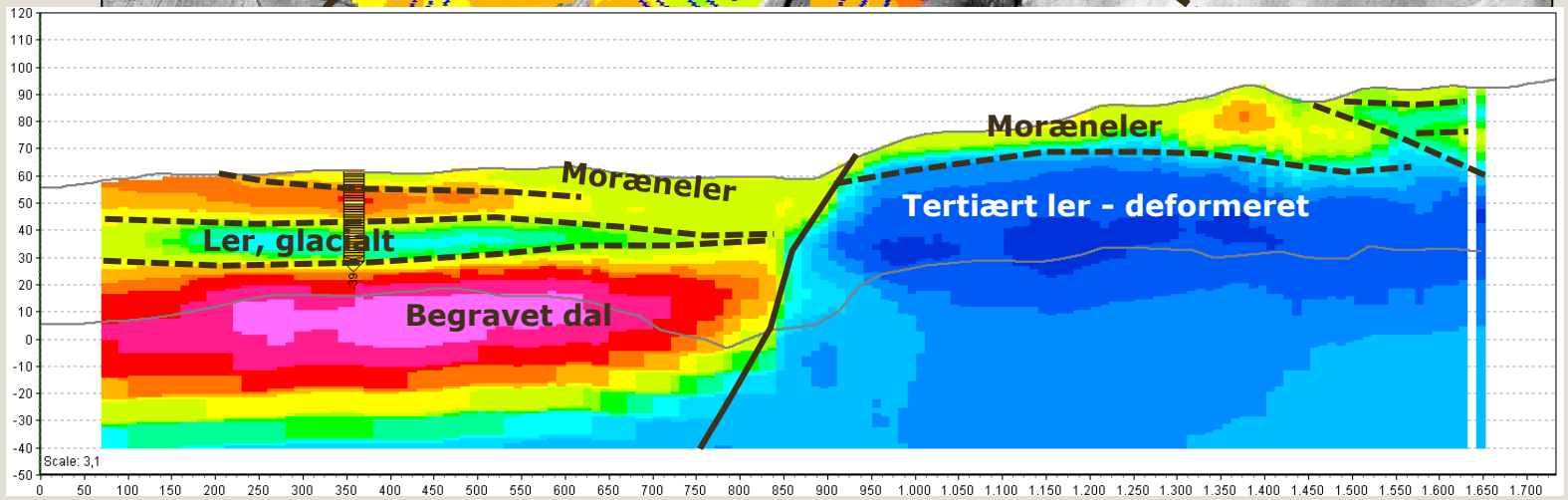
Lillerupgård

tTEM data

- Profil 1



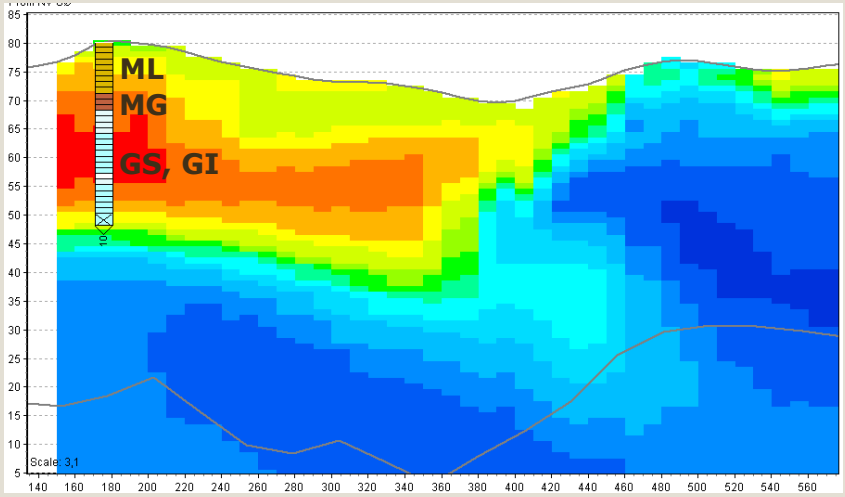


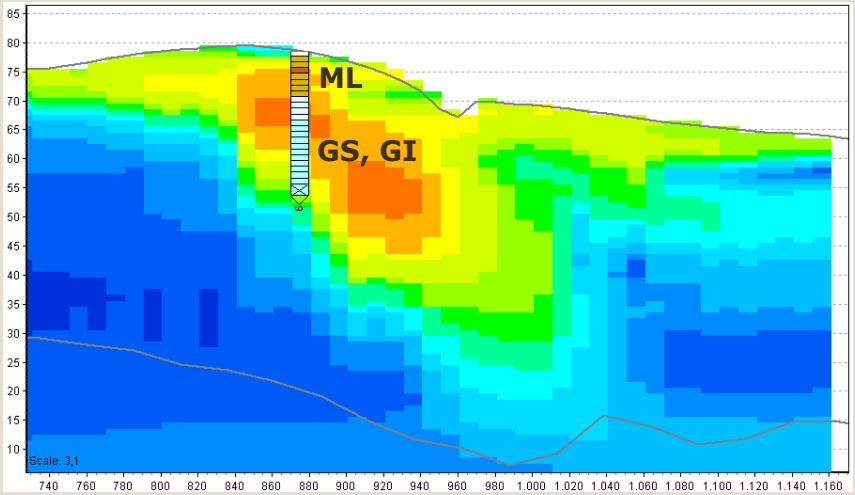


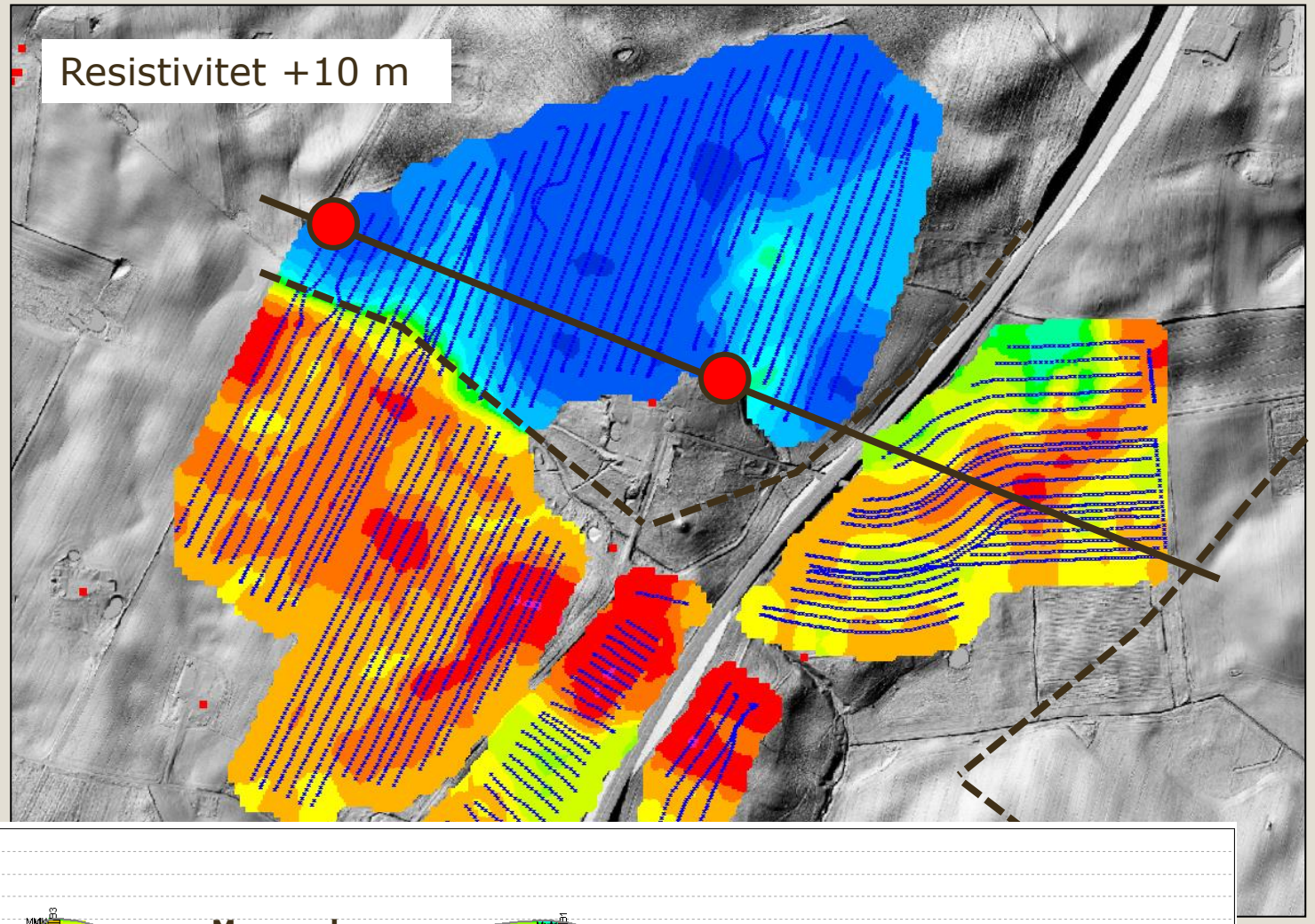
Lillerupgård

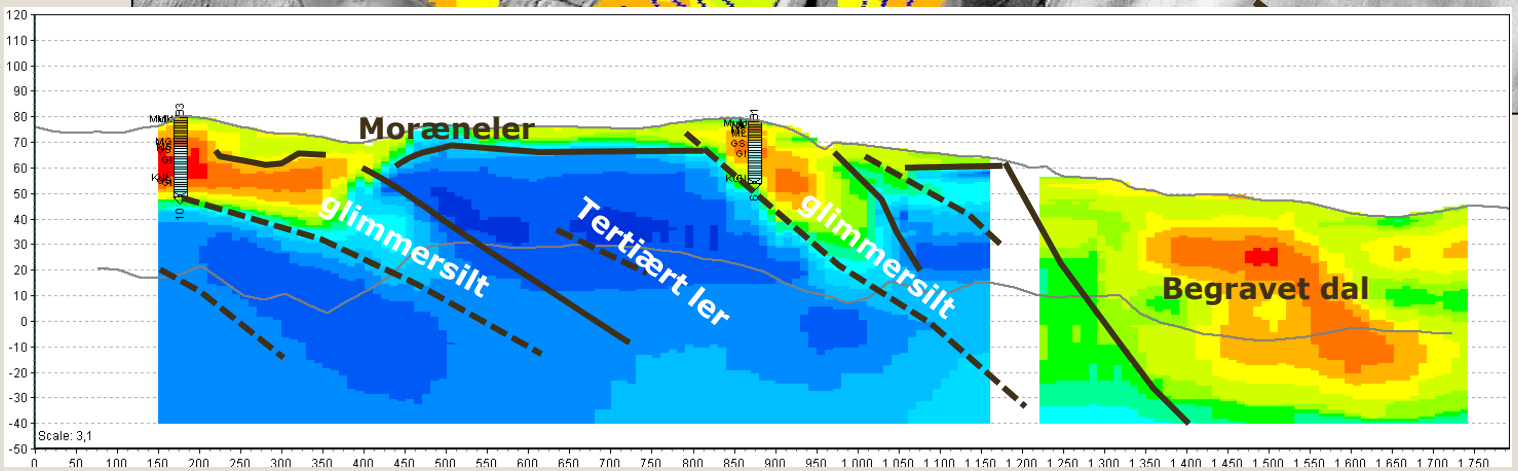
tTEM data

- Profil 2



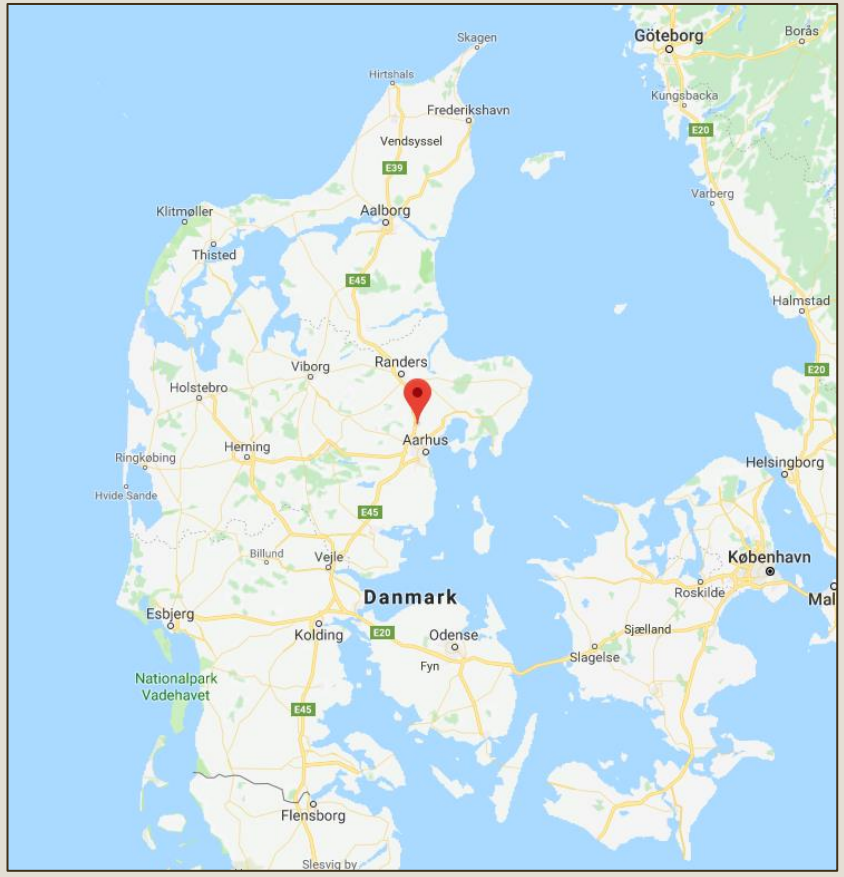






Trige

- tTEM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Borås
Hirtshals
Kungsbacka
Frederikshavn
Vendsyssel
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Klitmøller
Aalborg
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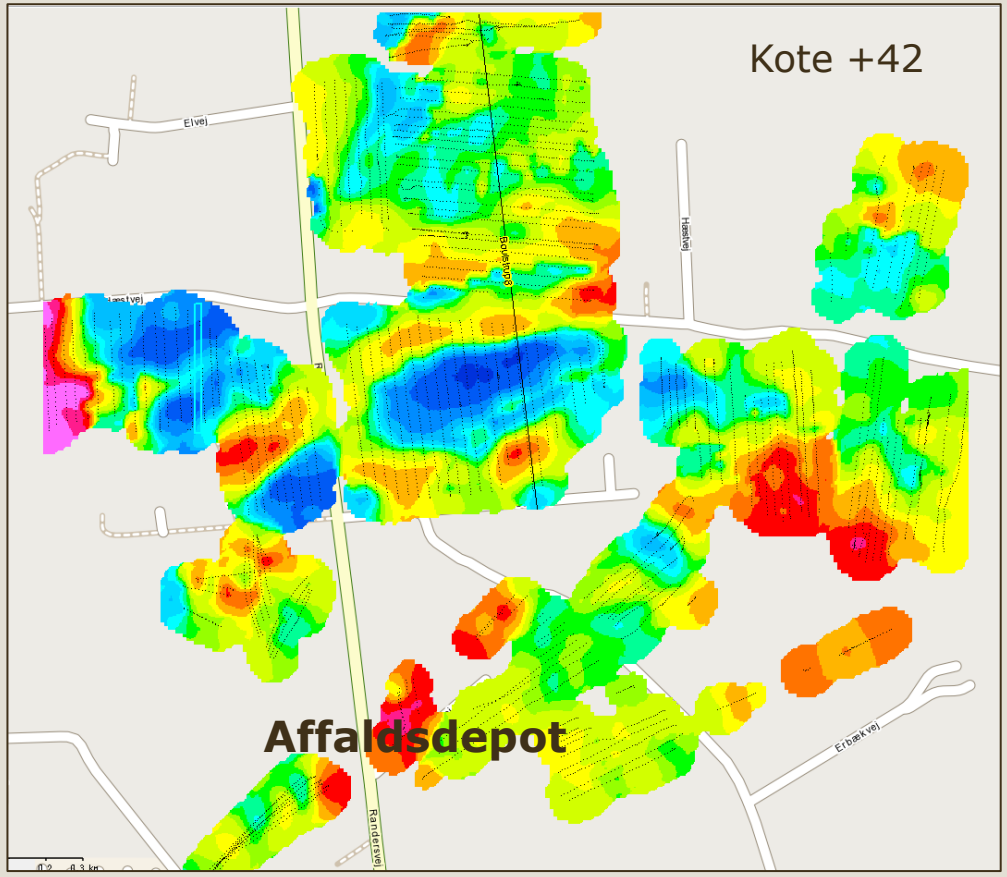
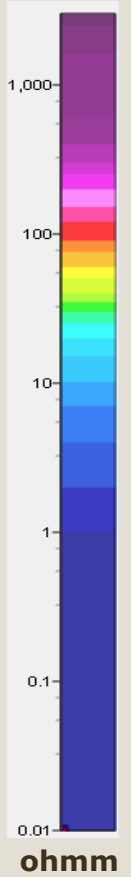
Viborg
Randers
Holstebro
Aarhus
Ringkøbing
Herning
Helsingborg
Hvide Sande
Billund
Vejle
København
Roskilde
Danmark
Esbjerg
Kolding
Odense
Sjælland
Fyn
Slagelse
Nationalpark
Vadehavet
Flensborg
Slesvig by


Kote +42
Affaldsdepot
Elvej
Erbæk vej


1,000
100
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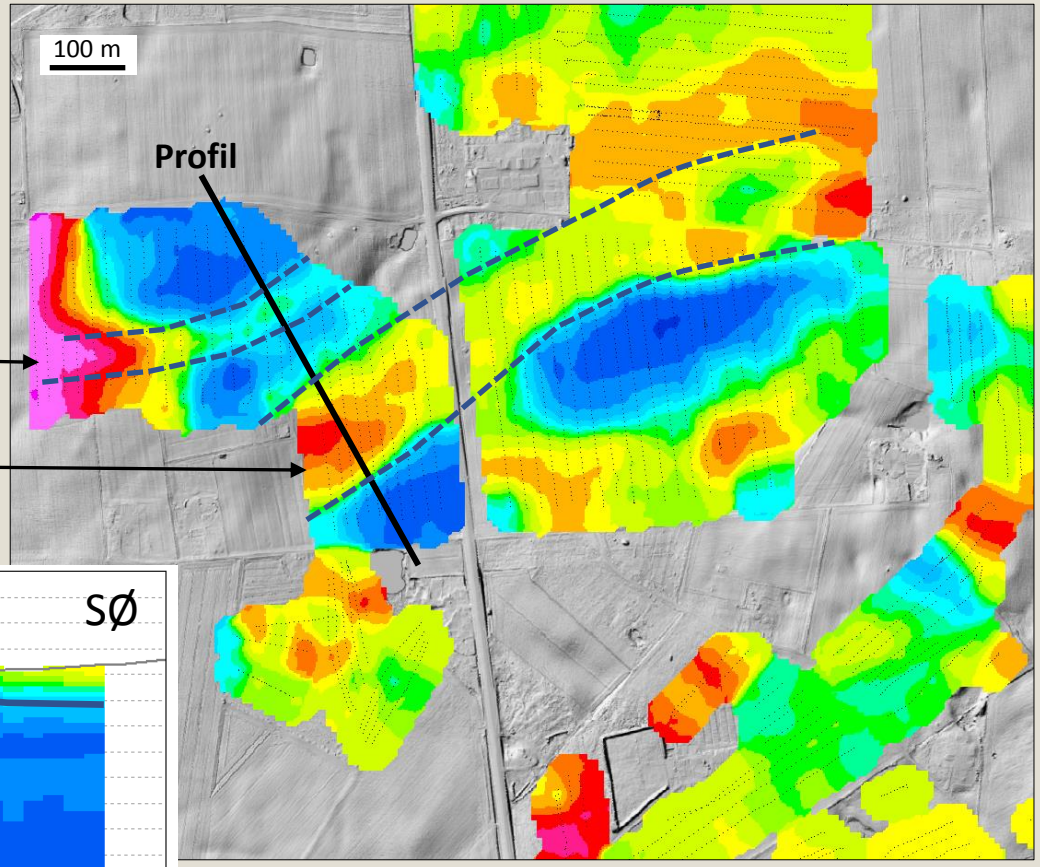
ohmm

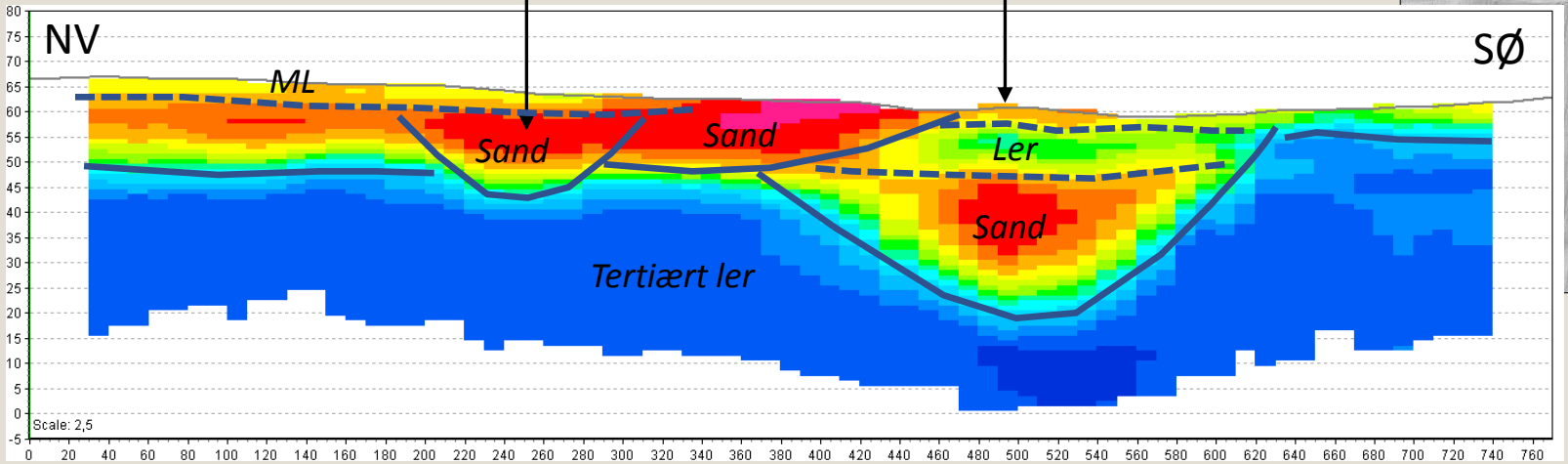
Trige

- Kortlægning af begravede dale



Yngre dal

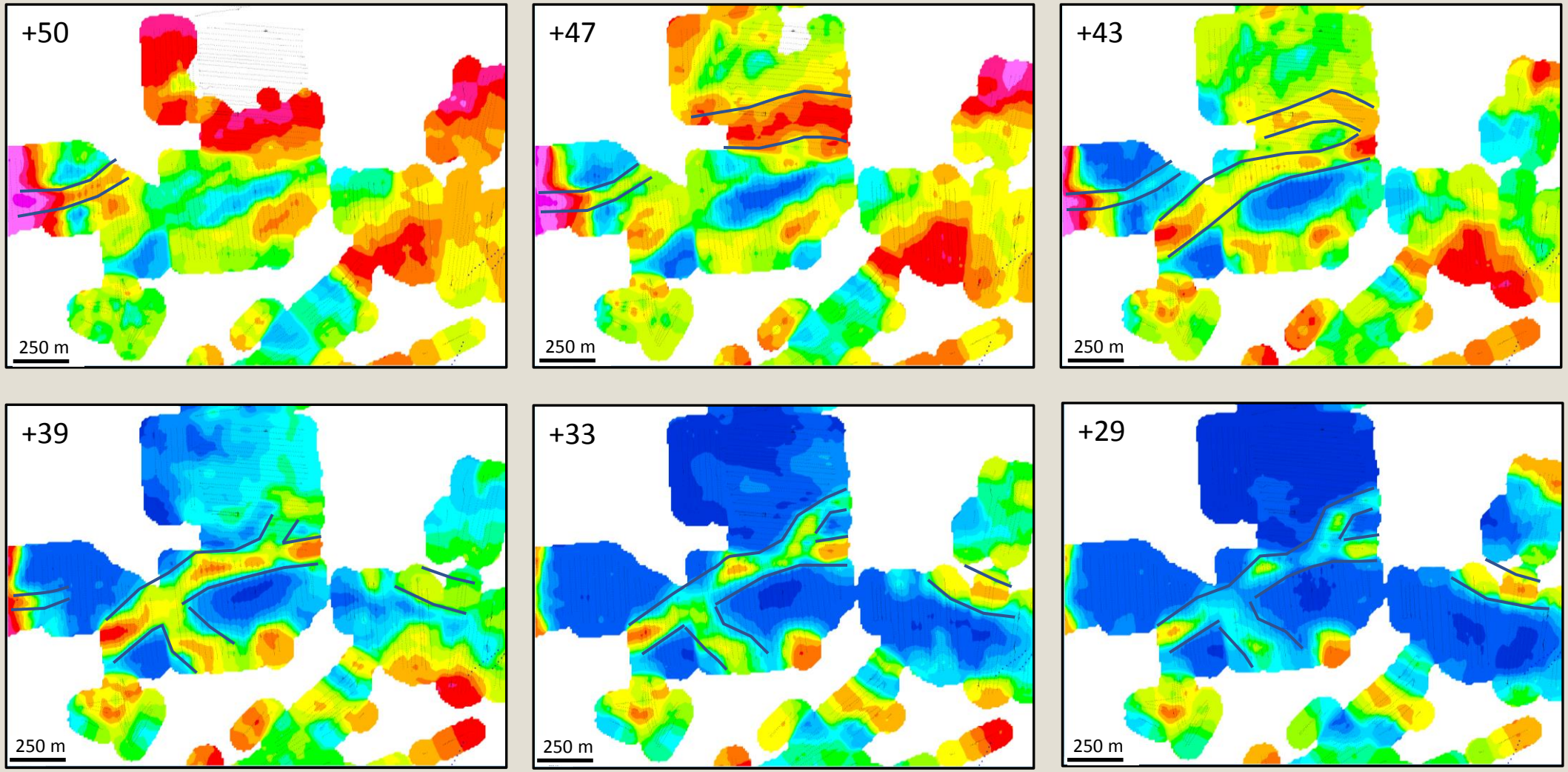
Ældre dal



Kote +44 m

Trige

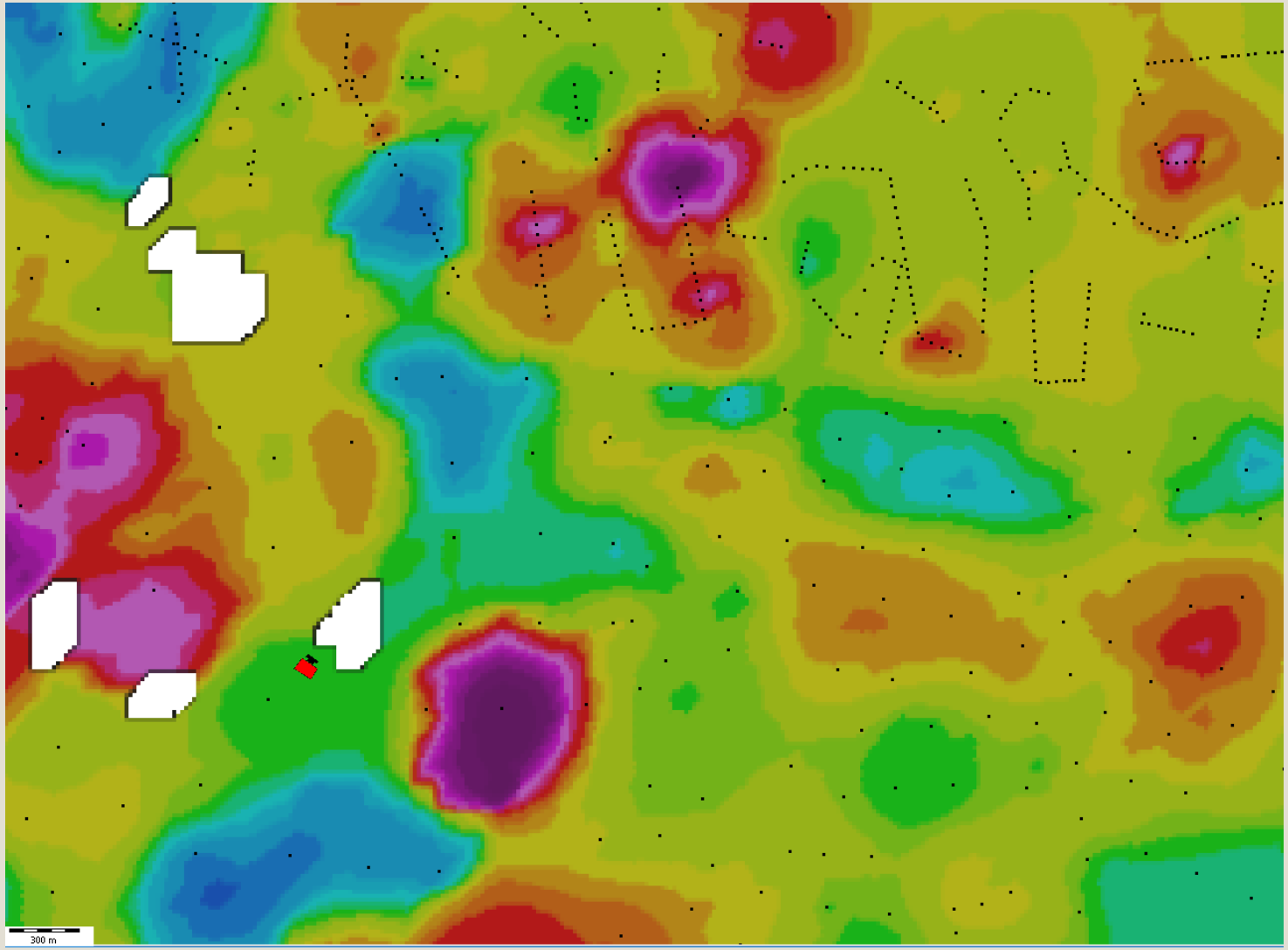
- Kortlægning af begravede dale



Trige

- Eksisterende TEM og SkyTEM

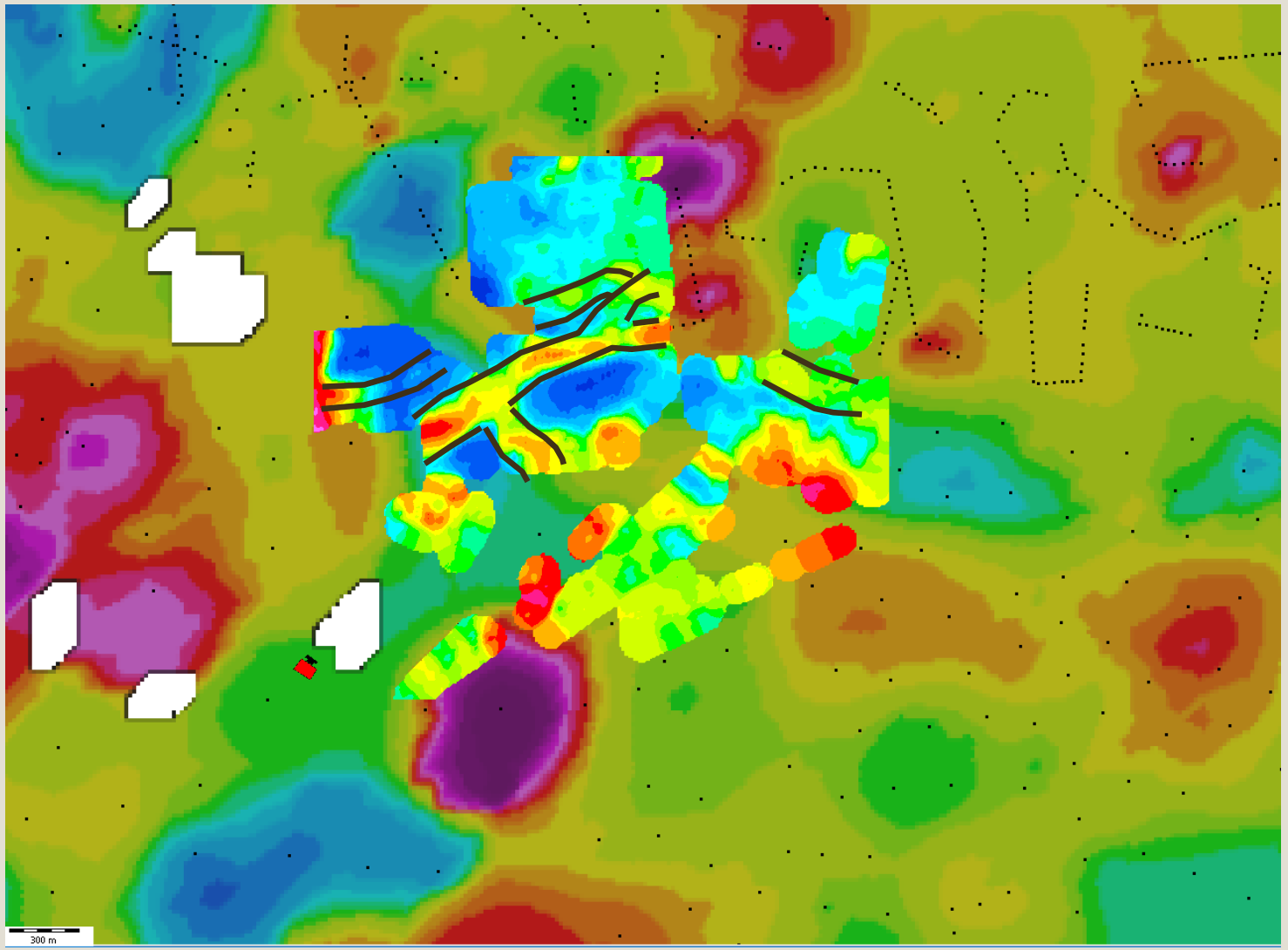
Kote +40 m



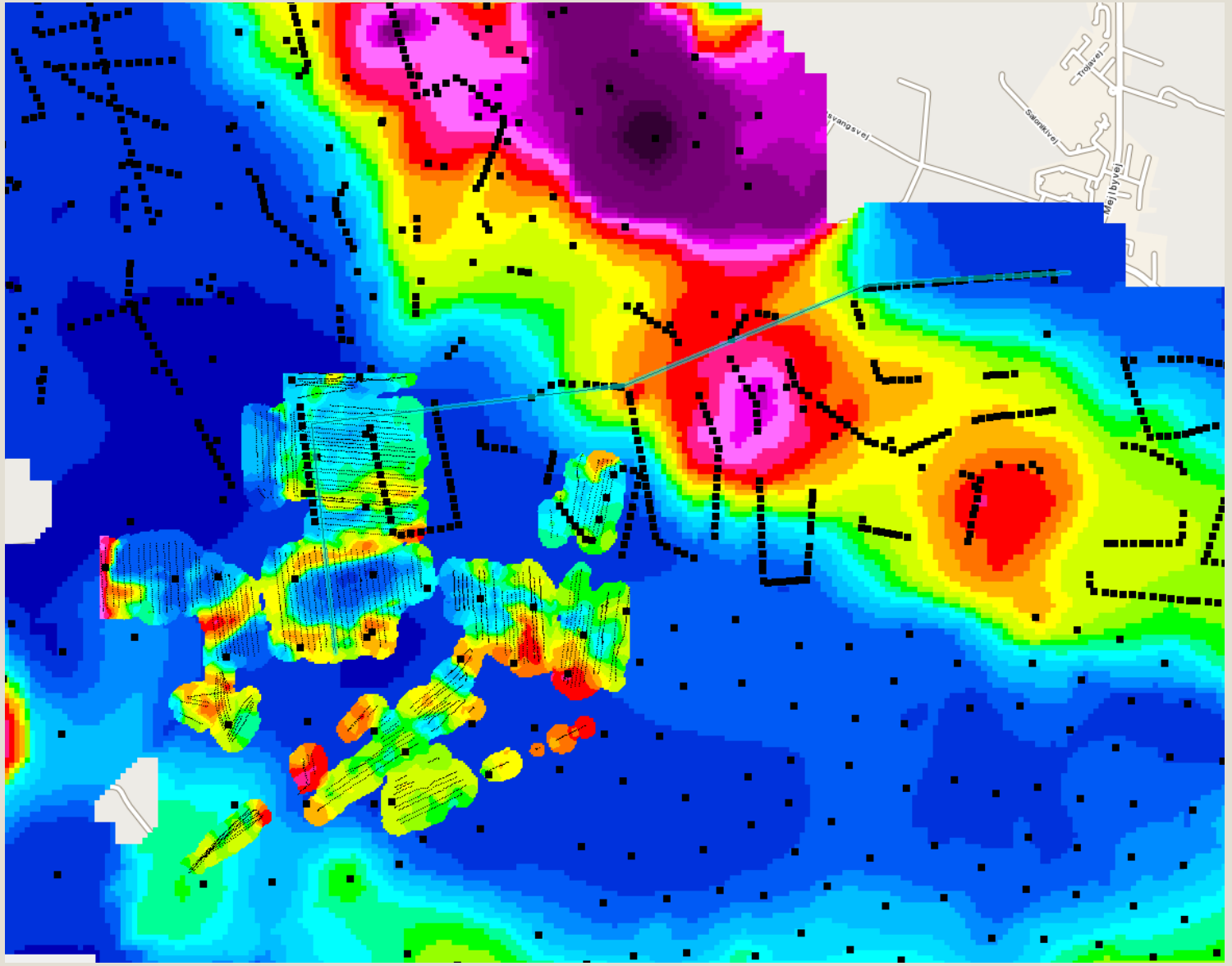
Trige

- tTEM
- Begravede dale

Kote +40 m



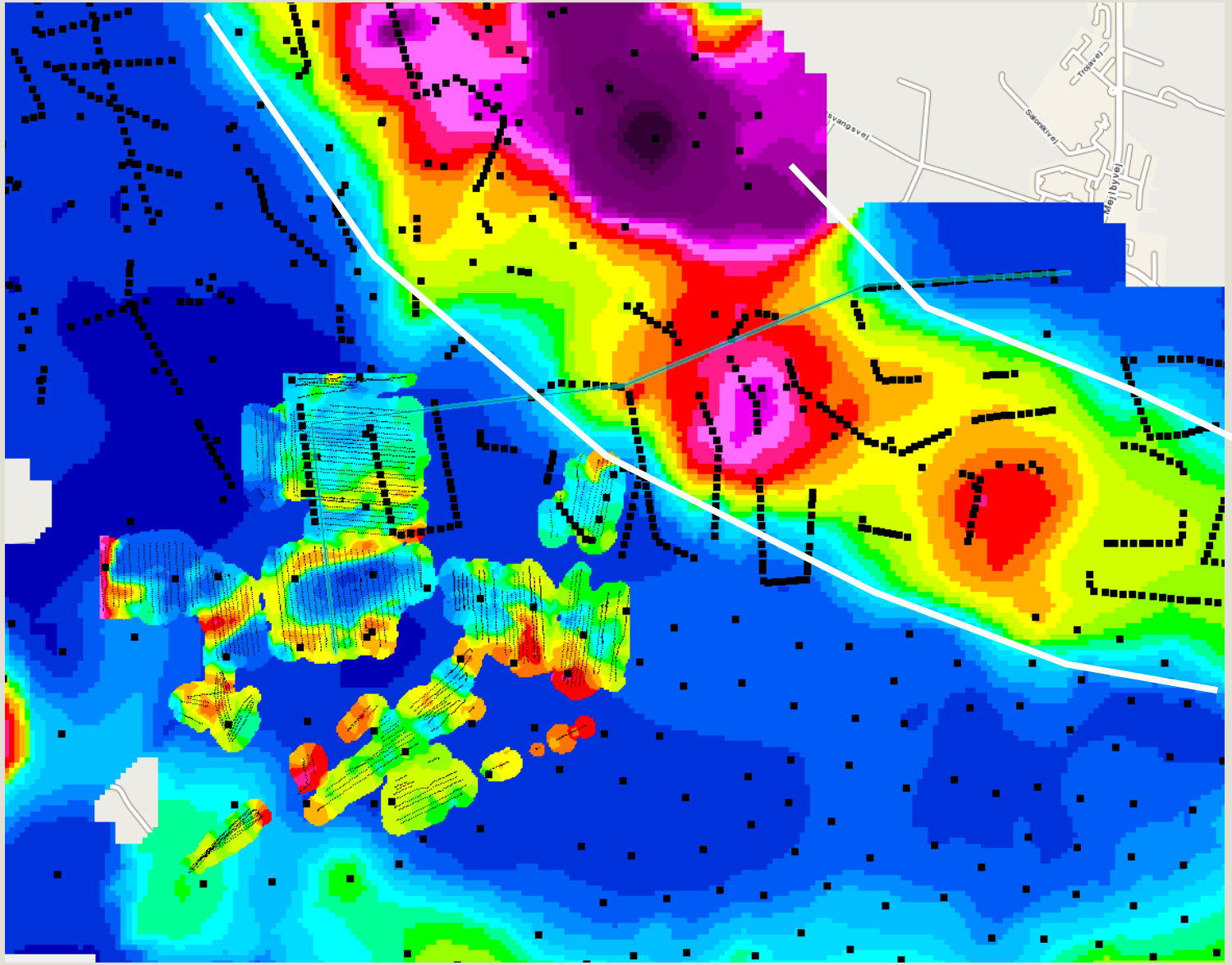
Trige



tTEM: kote +40 m

SkyTEM/TEM: kote -40 m

Trige

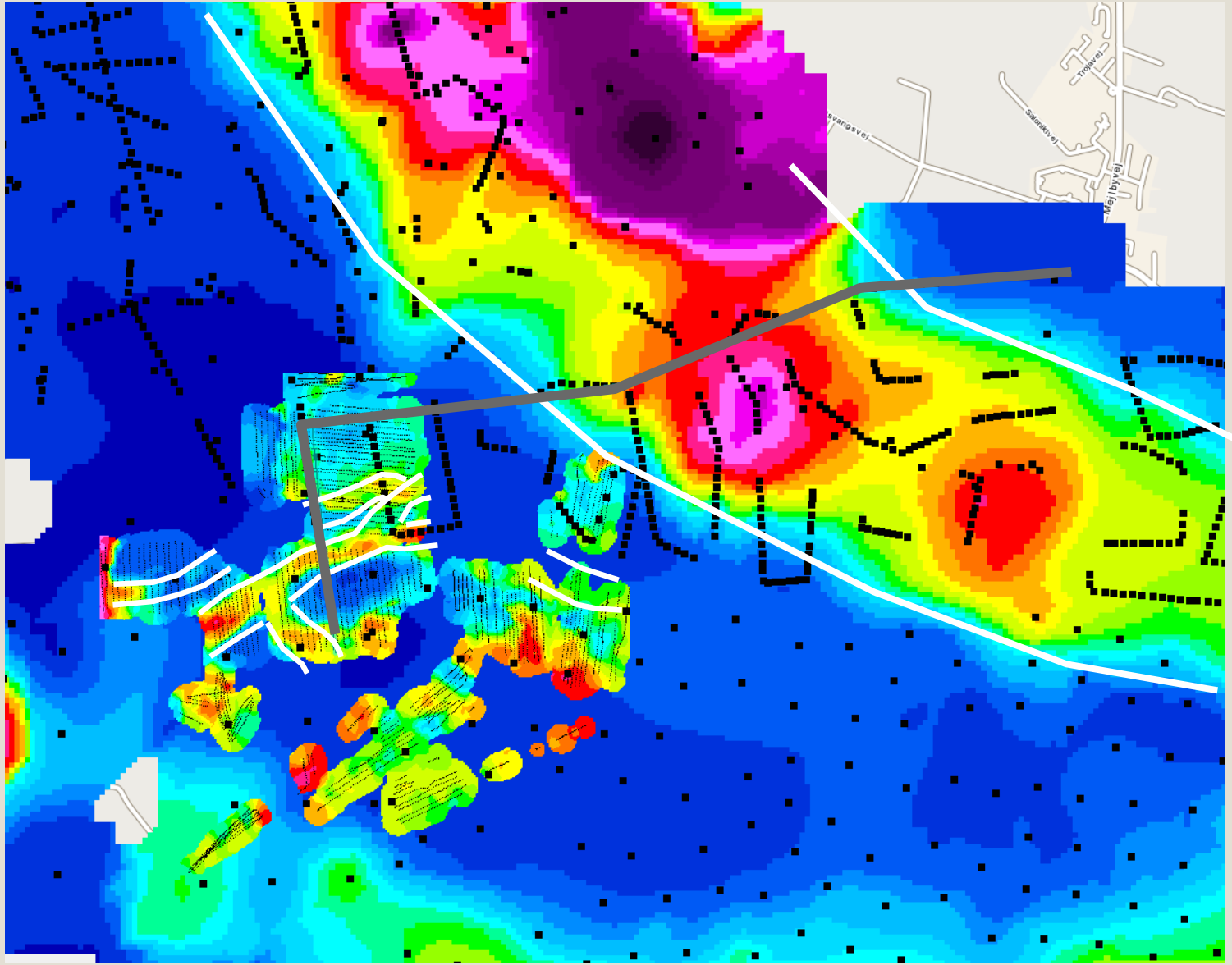


tTEM: kote +40 m

SkyTEM/TEM: kote -40 m

Kendte begravede dale:
500-3000 m brede
30-300 m dybe

Trige



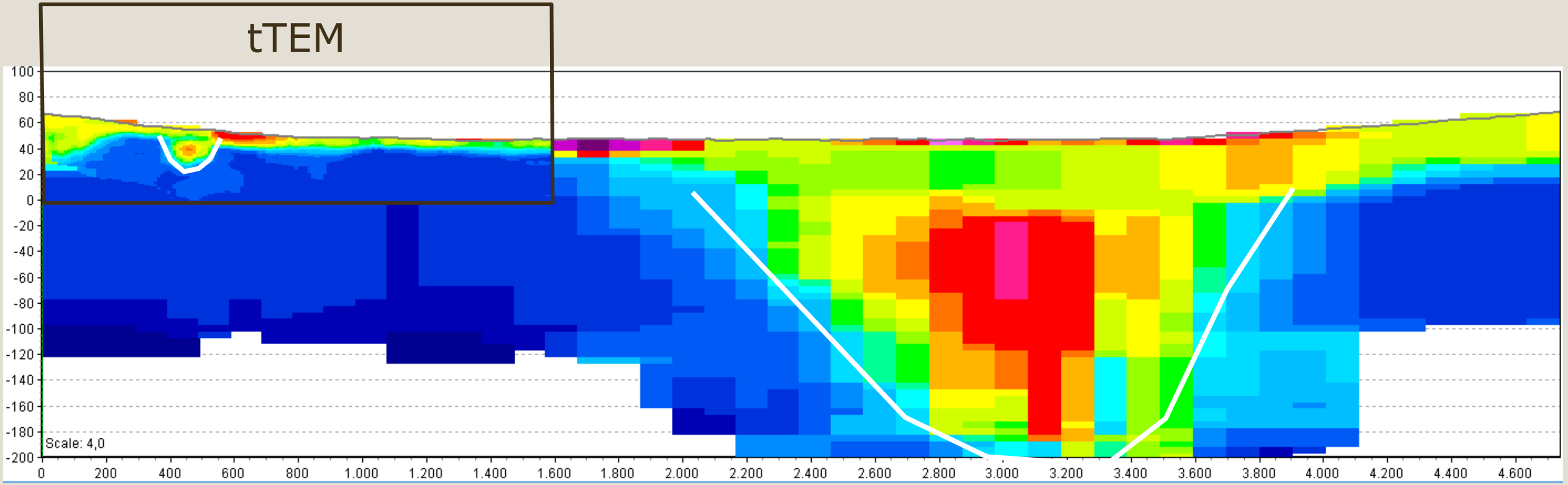
tTEM: kote +40 m

SkyTEM/TEM: kote -40 m

"Nye" begravede dale:
30-500 m brede 5-30 m dybe

Kendte begravede dale:
500-3000 m brede
30-300 m dybe

Trige


tTEM
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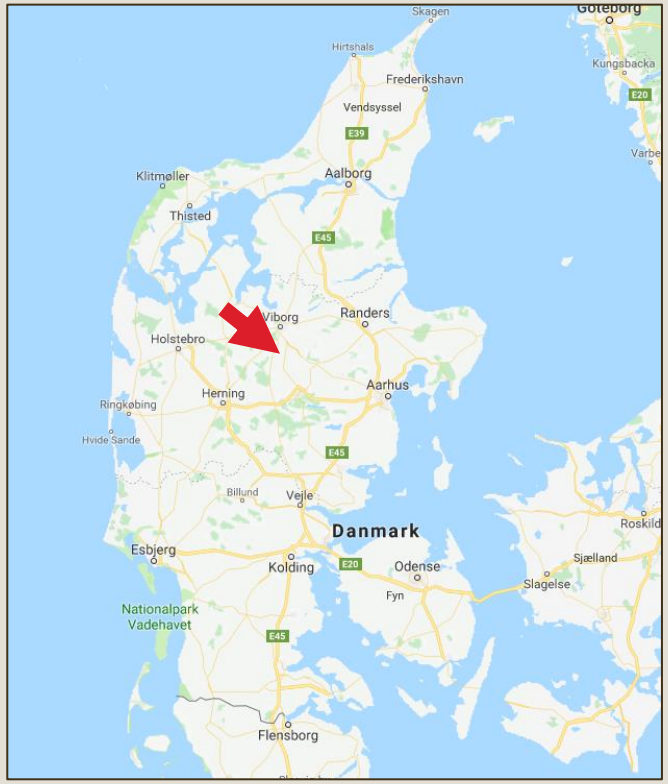
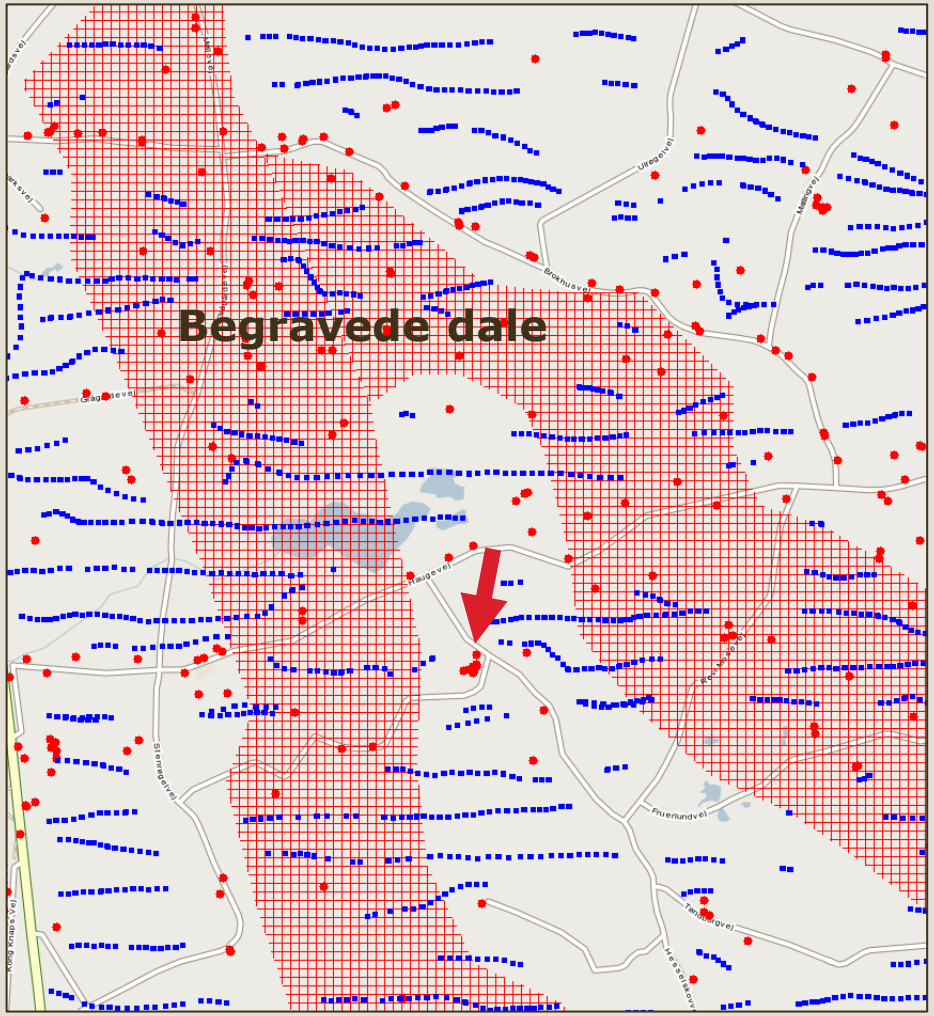
4.600

Hauge

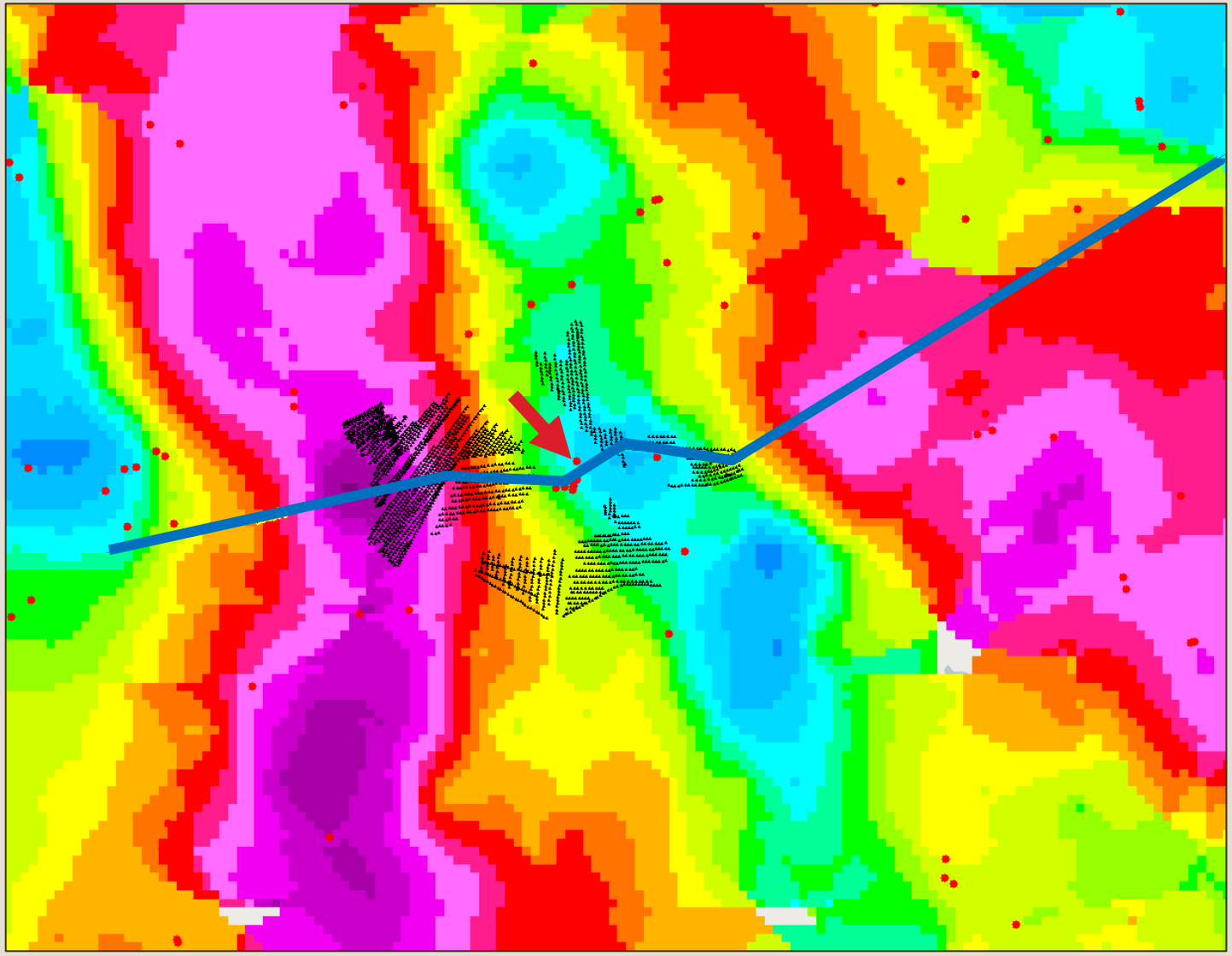
Pesticidforurening fra maskinstation





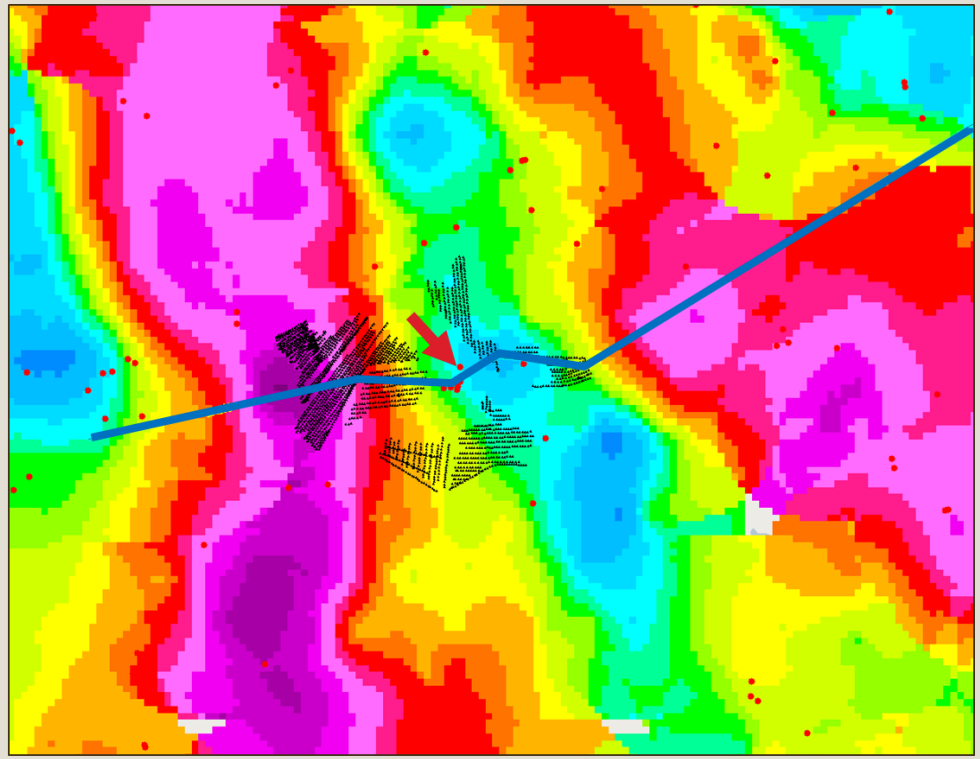
Hauge

- SkyTEM
- tTEM



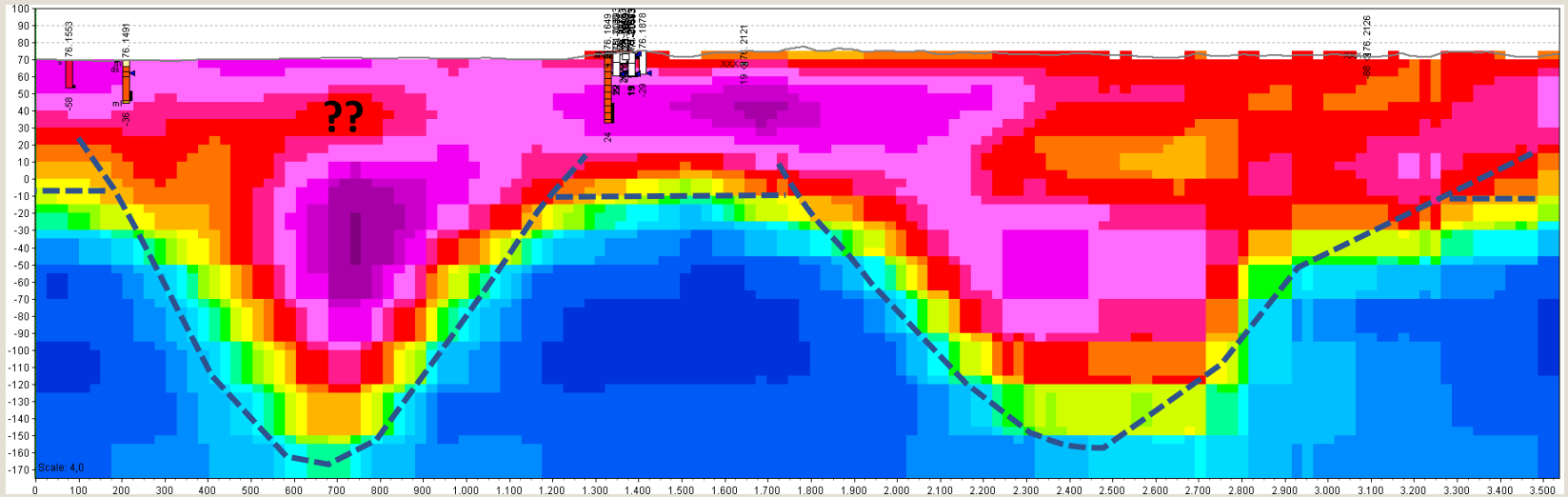
Kote -20 m

Hauge



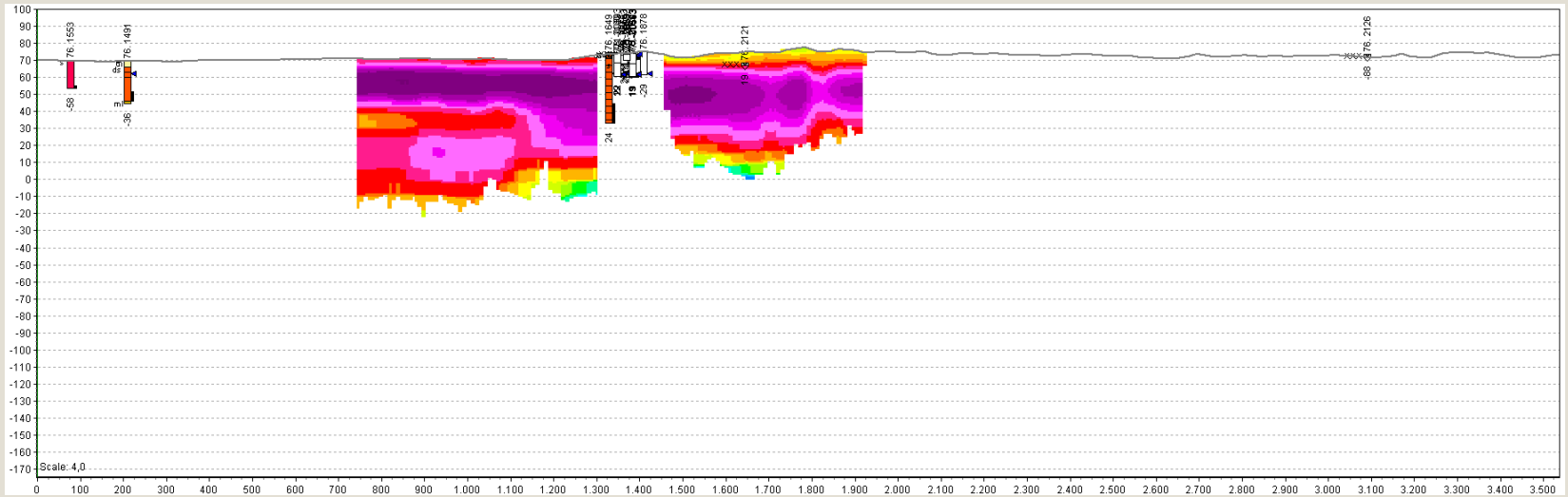
Kote -20 m

Punktkilde

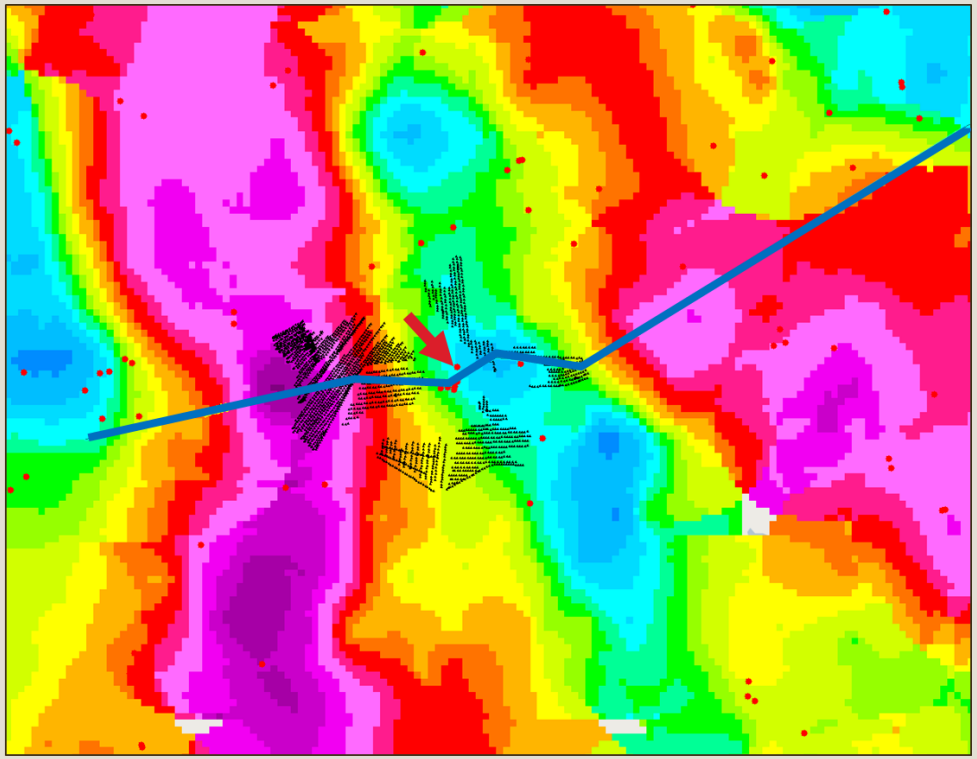


Hauge

Punktkilde

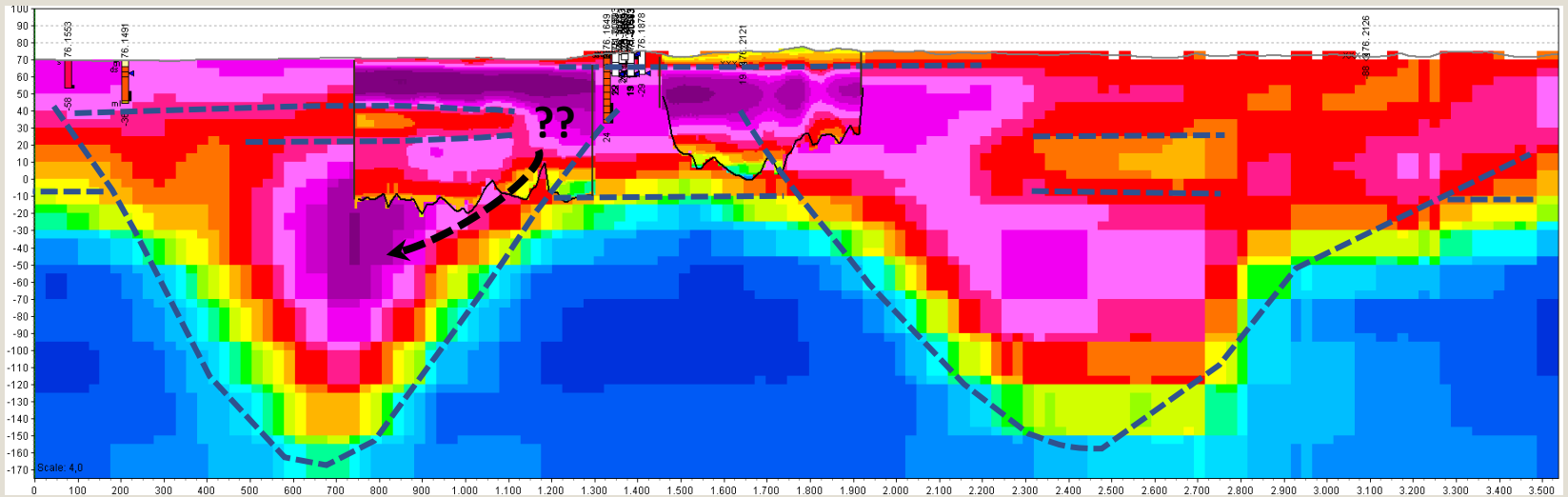


Kote -20 m

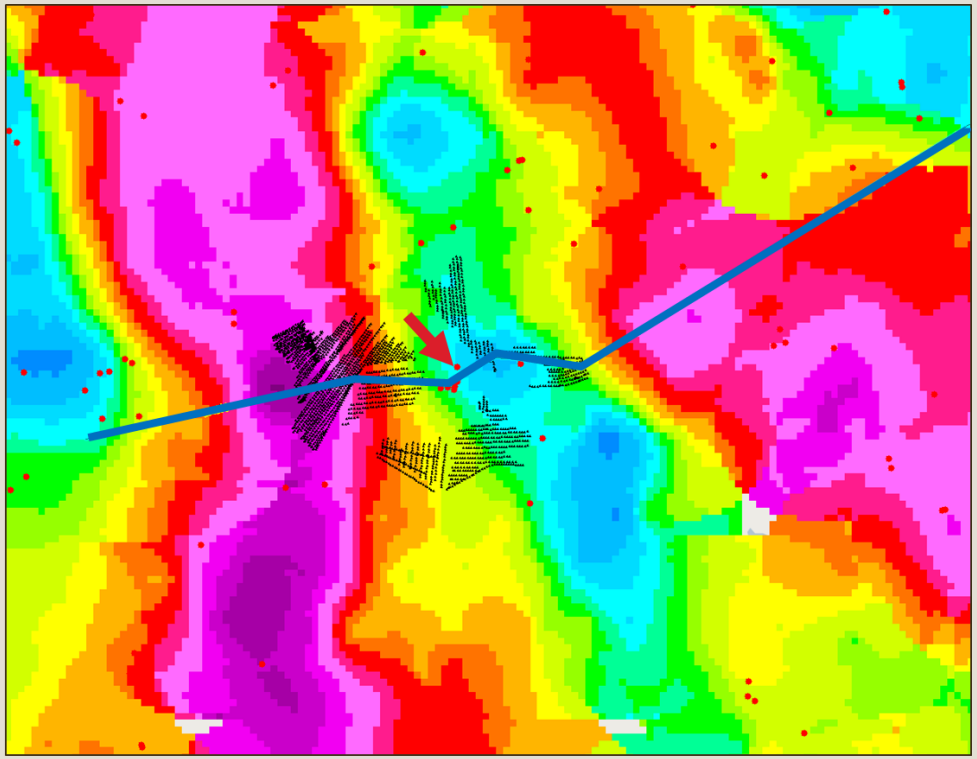


Hauge

Punktkilde



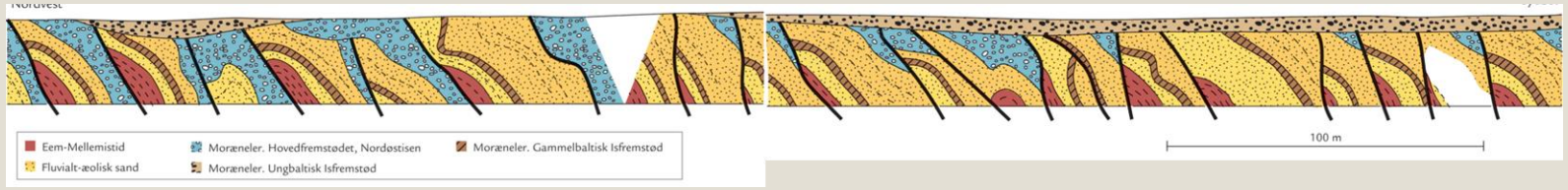
Kote -20 m



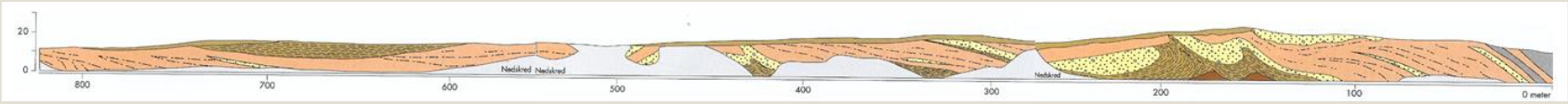
Den grundlæggende udfordring

- Deformeret geologi
- Erosion (fx begravede dale)
- Facies variationer

Ristinge Klint



Trelde Næs

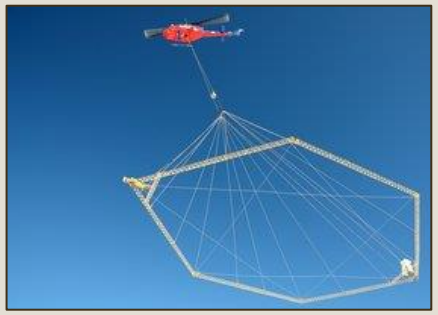


Kortlægning, hvordan?

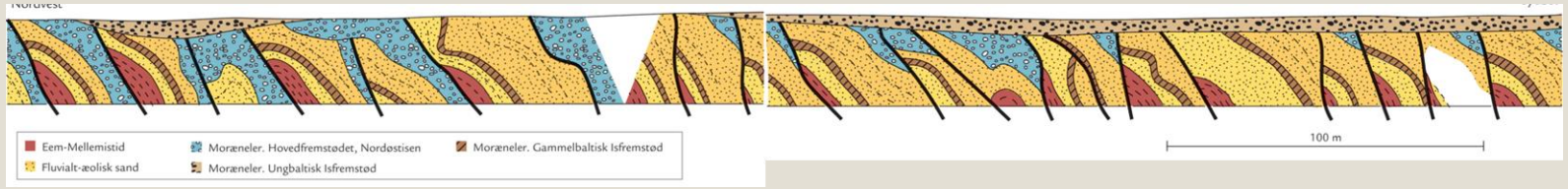
Modellering, hvordan?

Hvor vigtigt?

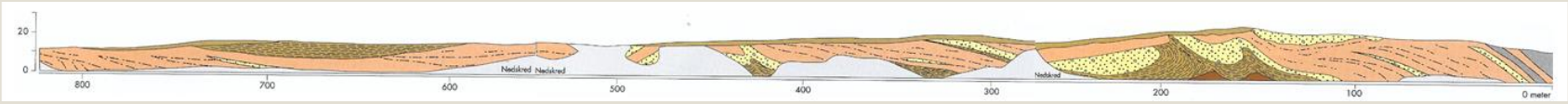
Den grundlæggende udfordring



Ristinge Klint



Trelde Næs



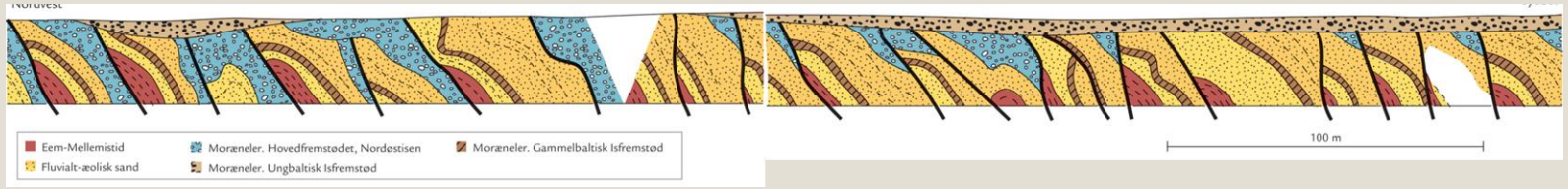
Kortlægning, hvordan?

Modellering, hvordan?

Hvor vigtigt?

Den grundlæggende udfordring

Ristinge Klint



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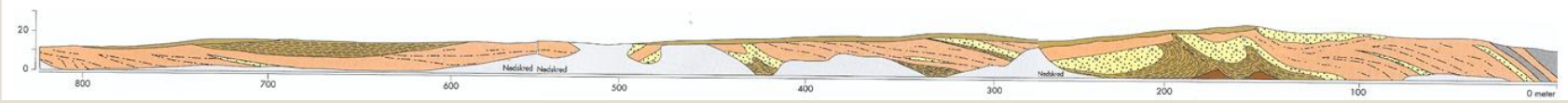
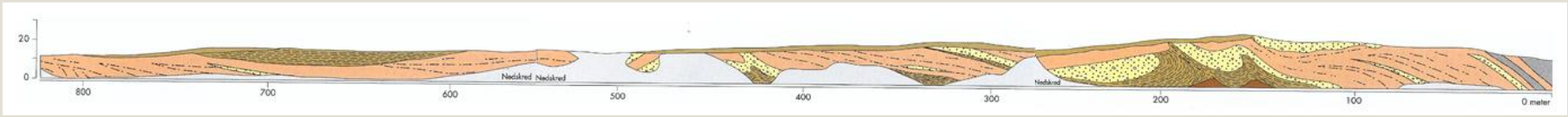


Kortlægning, hvordan?

Modellering, hvordan?

Hvor vigtigt?

Trelde Næs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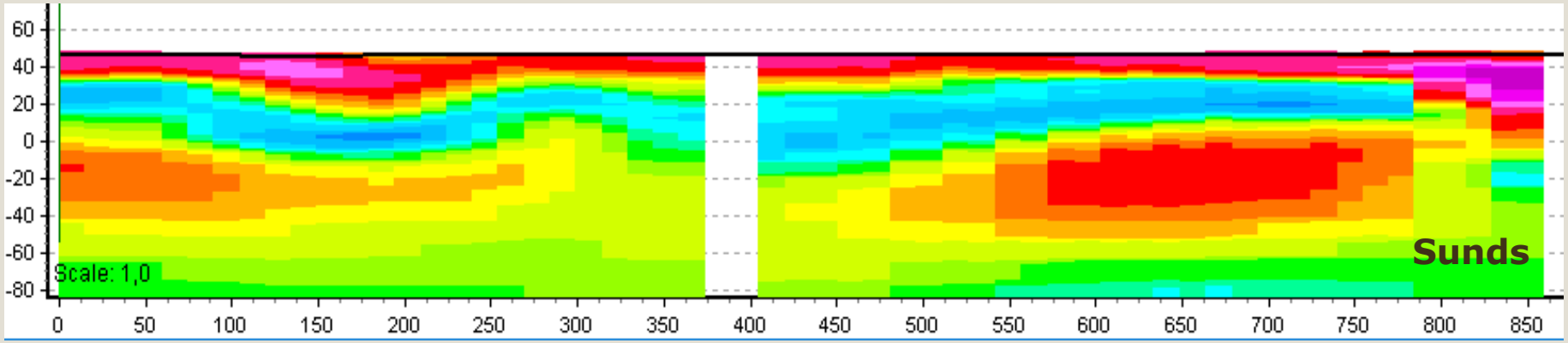
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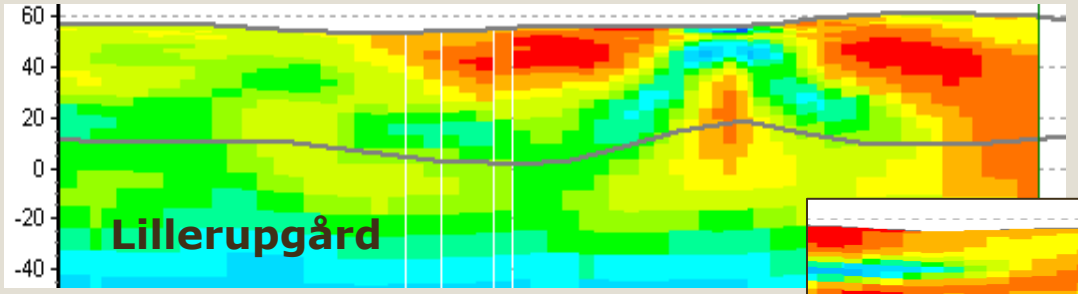
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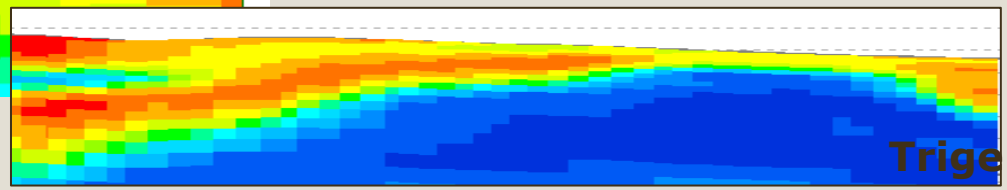
Trige

Konklusion

- tTEM giver et nyt indblik i vores øvre undergrund
- tTEM kan med fordel anvendes, hvor der er behov for detaljeret rumlig kortlægning
- Der kan spares penge i undersøgelsesprogrammerne
- Vores risikovurderinger bliver mere sikre, og beslutninger kan tages på et bedre grundlag

Men..

- Data skal oversættes til geologi/hydrogeologi, forskellige faldgruber
- Problemer i byområder
- Behov for større indtrængningsdybde
- Behov for endnu bedre opløsning

Tak!