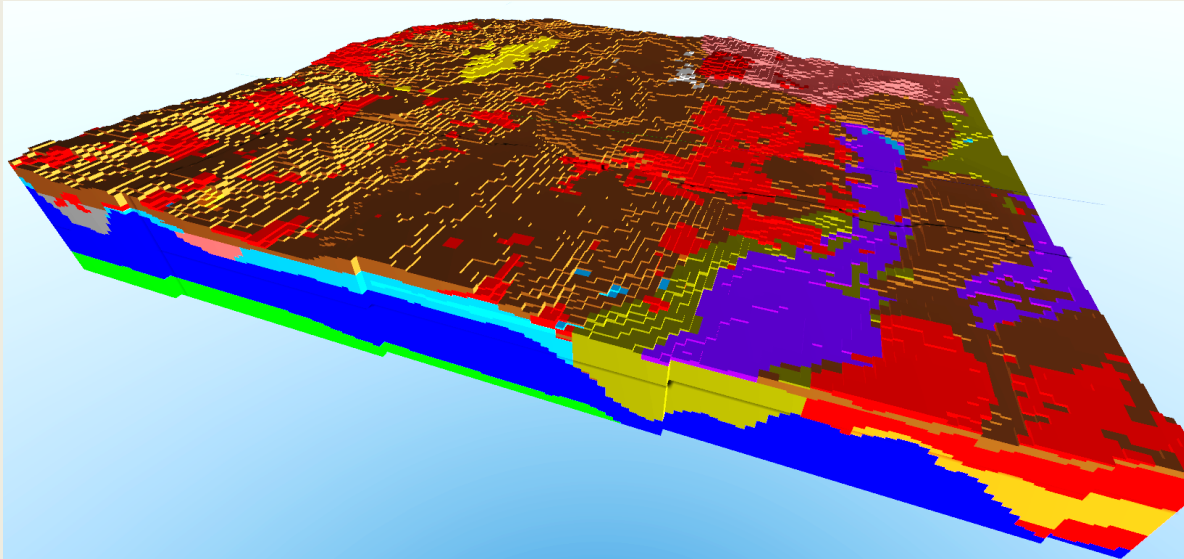




GEUS

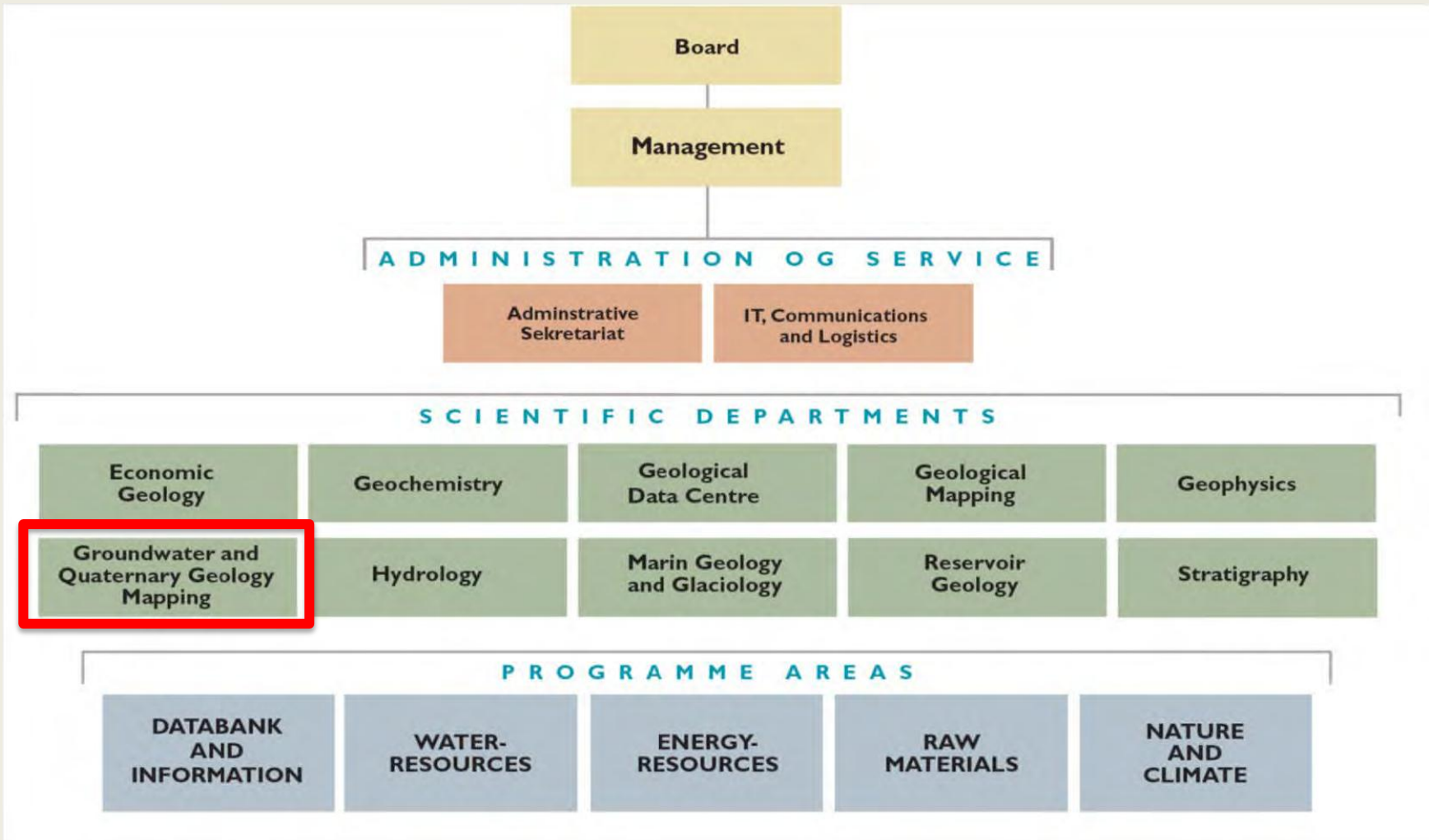


# Presentation of GEUS

Anders Vest Christiansen

Geological Survey of Denmark and Greenland, GEUS

# Who are we?



# Who are we?

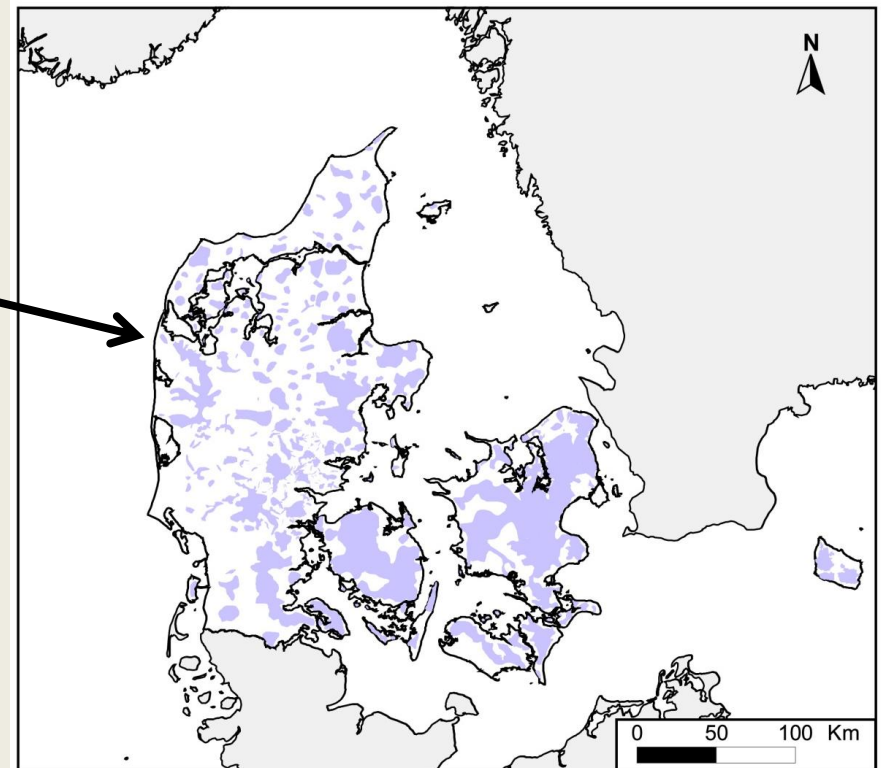
- Richard Thomsen
  - Head of department
- Flemming Jørgensen, Senior Researcher
  - Geologist, 3D geology, data integration
- Ingelise Møller Balling, Senior Researcher
  - Geophysicist, databases, georadar, DC
- Kim Esbensen, Professor
  - Geologist, data analysis, geostatistics
- Anders Vest Christiansen, Senior Researcher
  - Geophysicist, airborne EM, data integration

# Groundwater mapping in Denmark

- National groundwater mapping program initiated in 1999
- Expected end: 2015
- Areas to be mapped
- Financed by water consumers paying extra 4 cents per m<sup>3</sup> of water

## Goals for the mapping project:

- To map aquifers, vulnerability and groundwater quality
- To establish geological and hydrogeological models
- To point out groundwater protection areas and to establish plans for future water supply



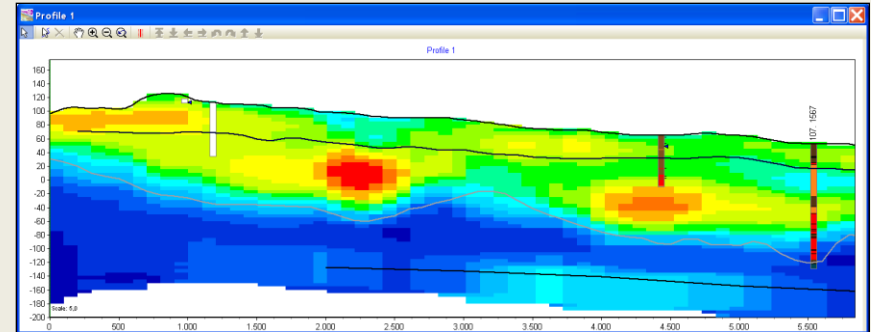
# HyGEM wishes

- Build a *neutral* 3D geological model of Denmark for multiple purposes
  - From the surface to basement
  - Cell sizes reflect data density
  - Huge amounts of existing data to incorporate

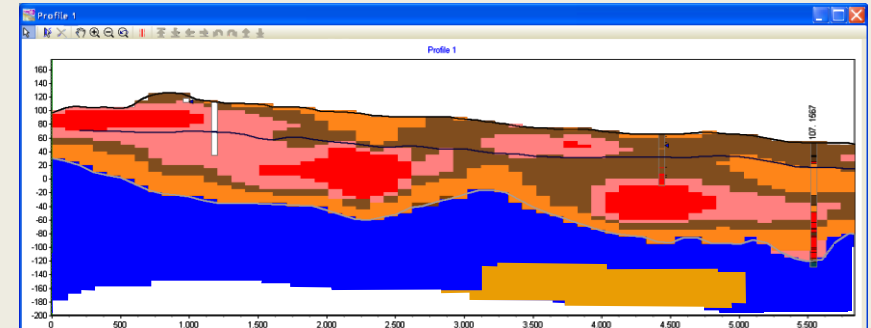
# Conversion from resistivity to lithology

>65 ohmm	Sand and gravel
50-65 ohmm	Alternating sand and clay layers
25-50 ohmm	Clay till
8-25 ohmm	Meltwater clay
0-8 ohmm	Paleogene clay

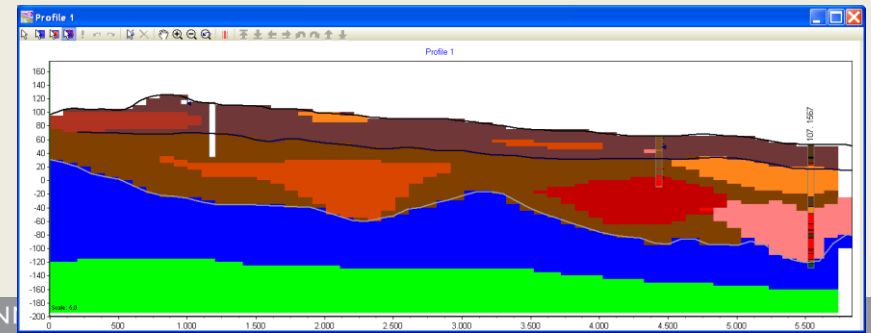
Resistivity grid



Lithology – direct converted



Lithology – manually interpreted



# 3D Lithological model

Meltwater sand  
and gravel

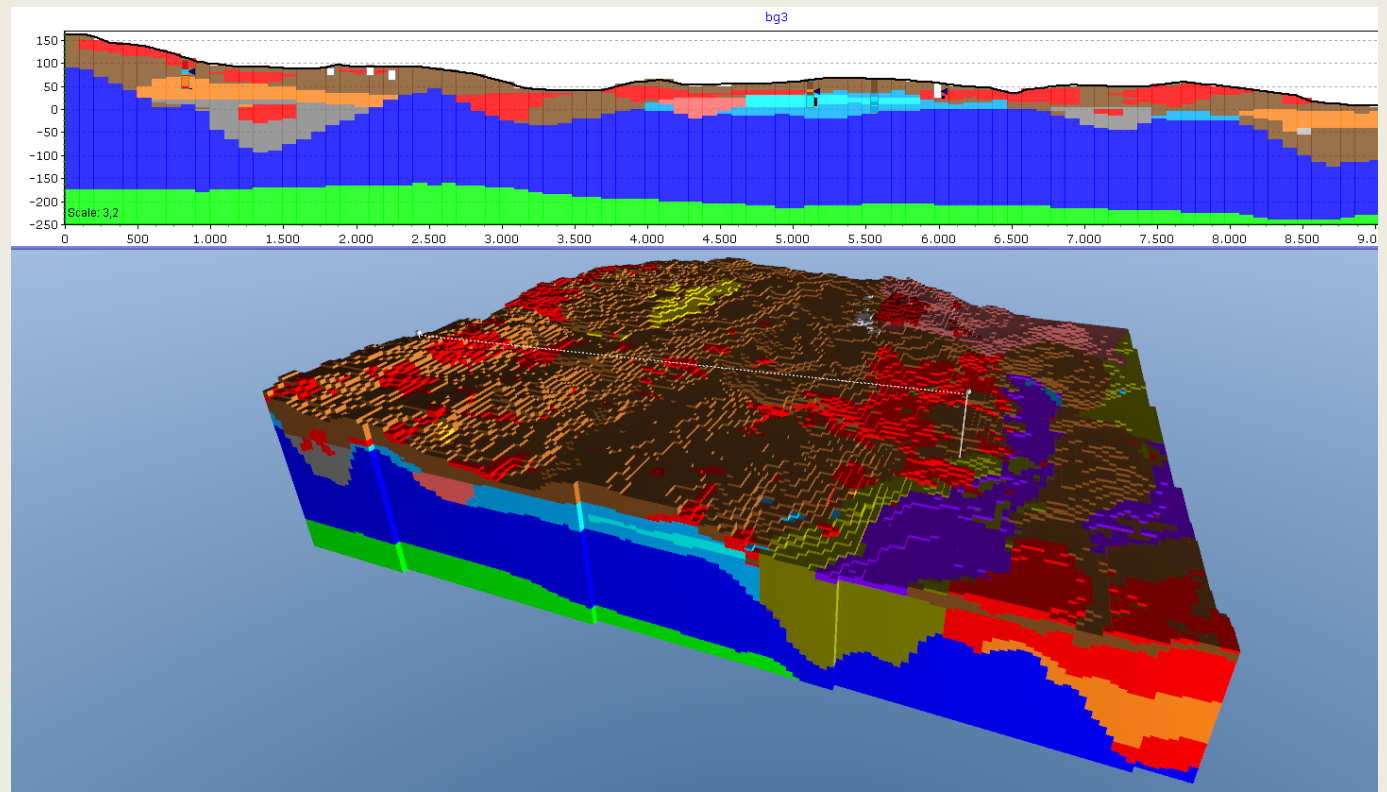
Clay till and  
glaciolacustrine  
clay

Miocene sand

Miocene clay

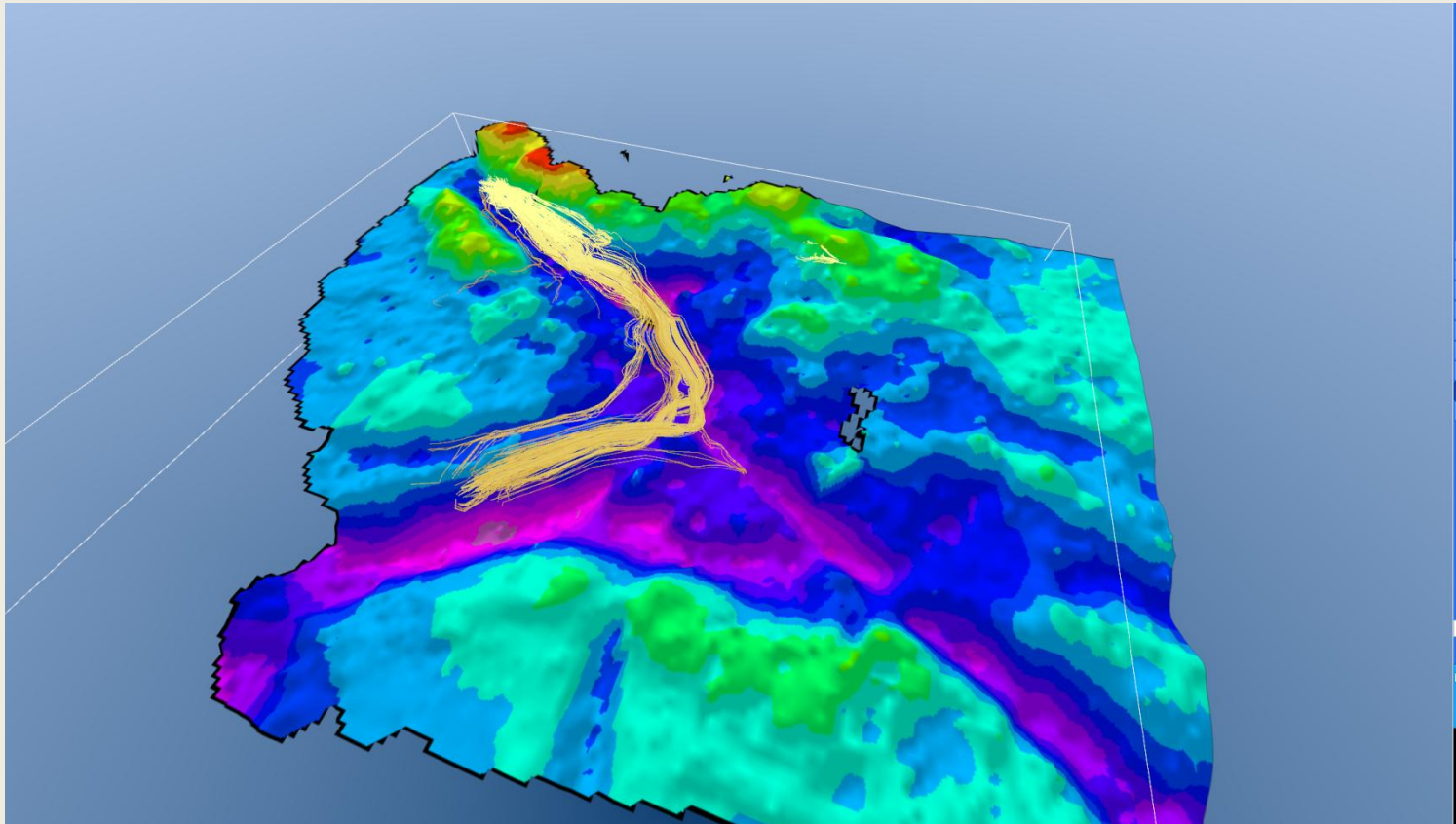
Paleogene Clay

Limestone



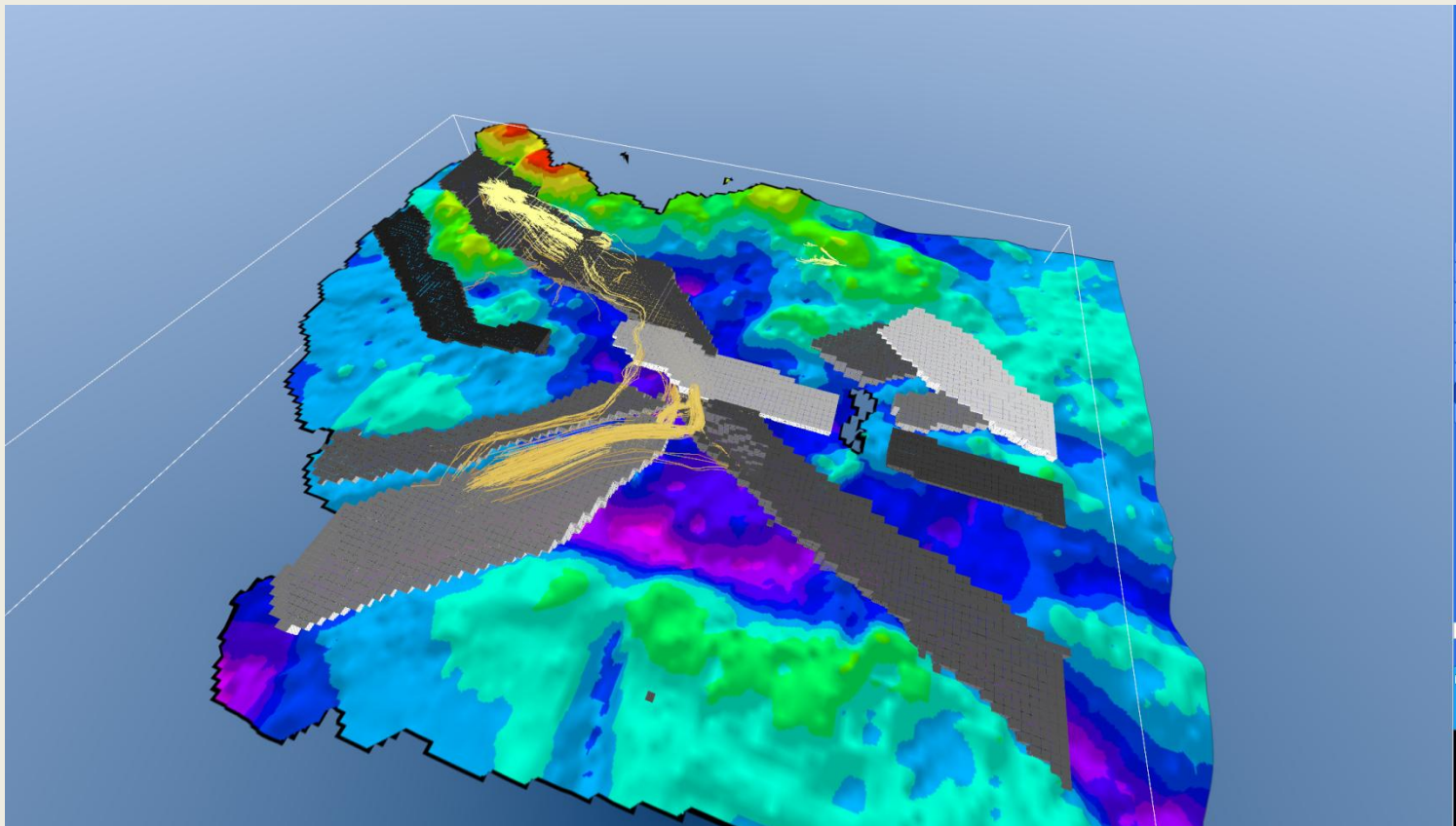
3 7 797 Højst: 0. Dir: 70. Til:

# Calculated groundwater flow pathlines



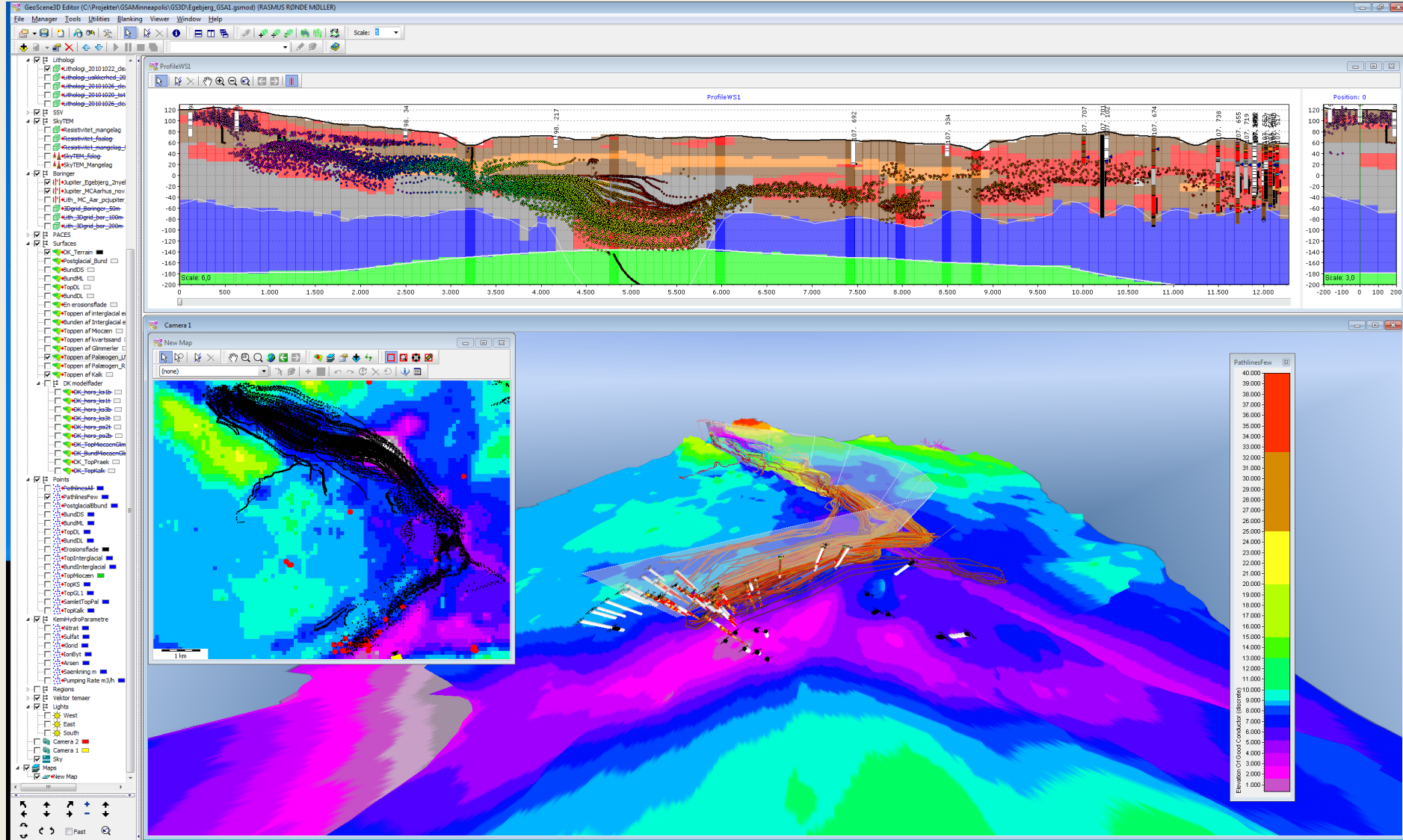


# ...are controlled by the buried valleys





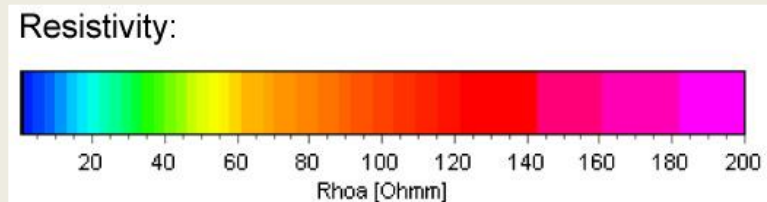
# Visualizing particles and path lines











# HyGEM wishes

- Build a *neutral* 3D geological model of Denmark for multiple purposes
  - From the surface to basement
  - Cell sizes reflect data density
  - Huge amounts of existing data to incorporate
- Resistivity atlas
  - Linking resistivity and lithology
  - Data analyses, databases

# Resistivity

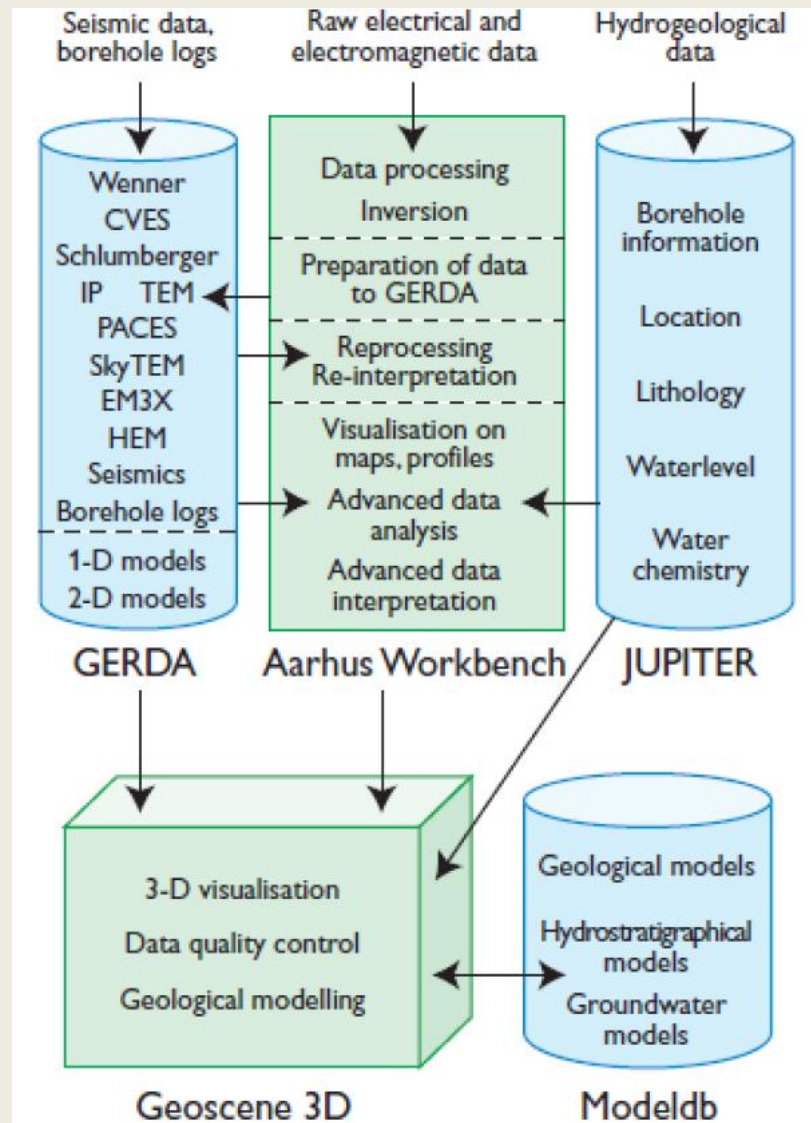


Sediments	Resistivity ( $\Omega$ m)
Meltwater sand and gravel	>60 
Clay till	25–50 
Glacio-lacustrine clay	10–40 
Neogene mica silt/sand: Miocene	>40 
Neogene mica clay: Miocene	10–40 
Paleogene clay: Eocene–Oligocene	5–12 
Paleogene clay: Paleocene–Eocene	1–7 
Danian limestone	>80 



**Done !**

# Data management



Integrated data management system, (Møller, I., et al. 2009)

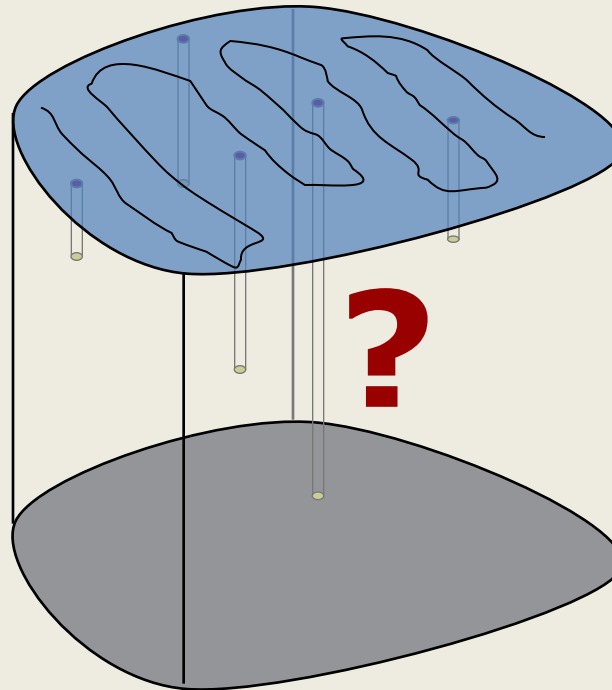
# 3D Geology

- HyGEM can provide (semi-)automatic models that can be used as a starting point
- SSV is an example currently being used

# Background and motivation

- 50000 airborne EM models (~ 1000 km)

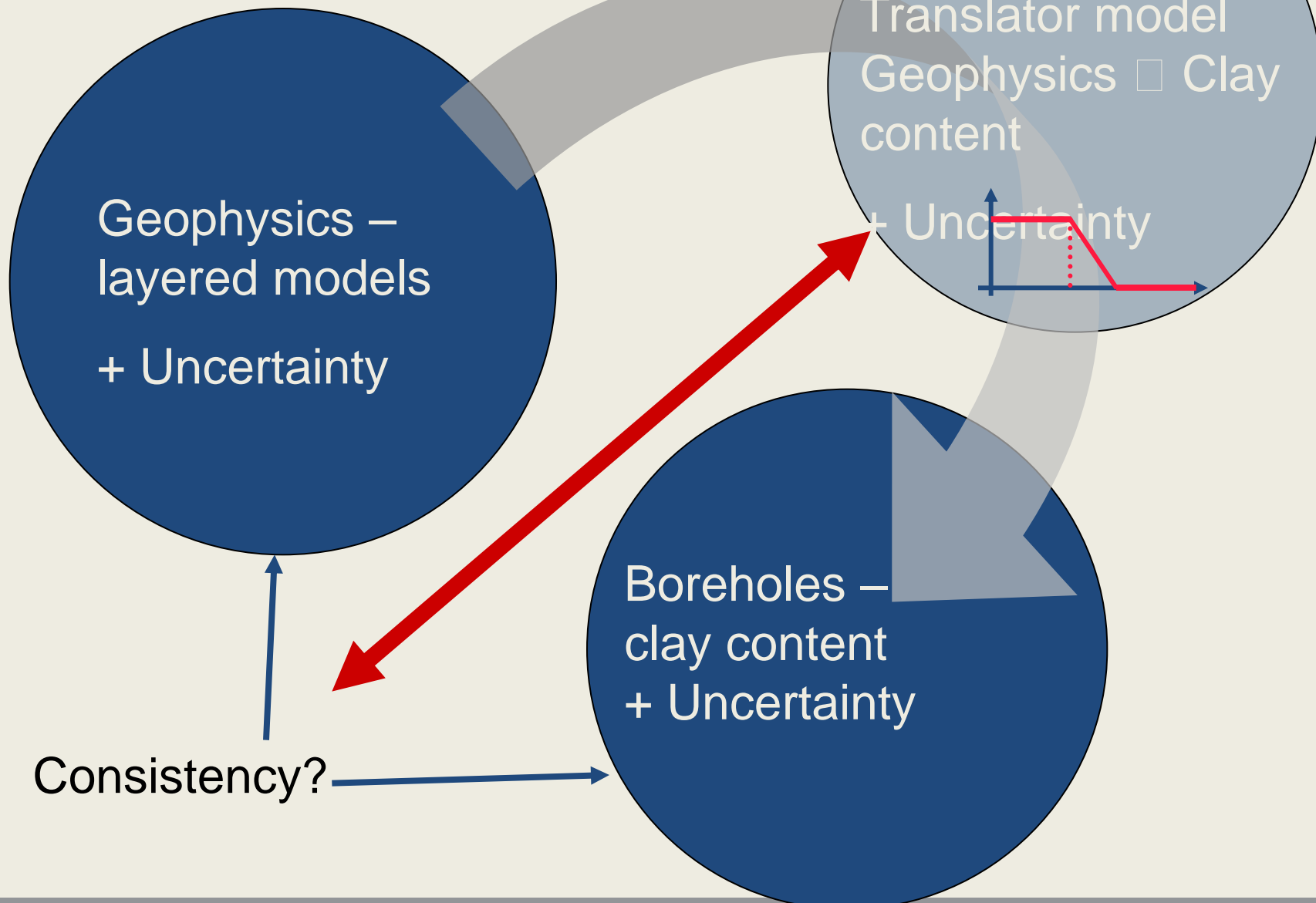
- 500 boreholes

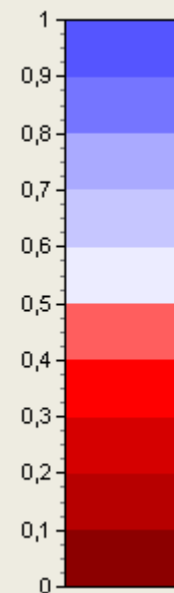
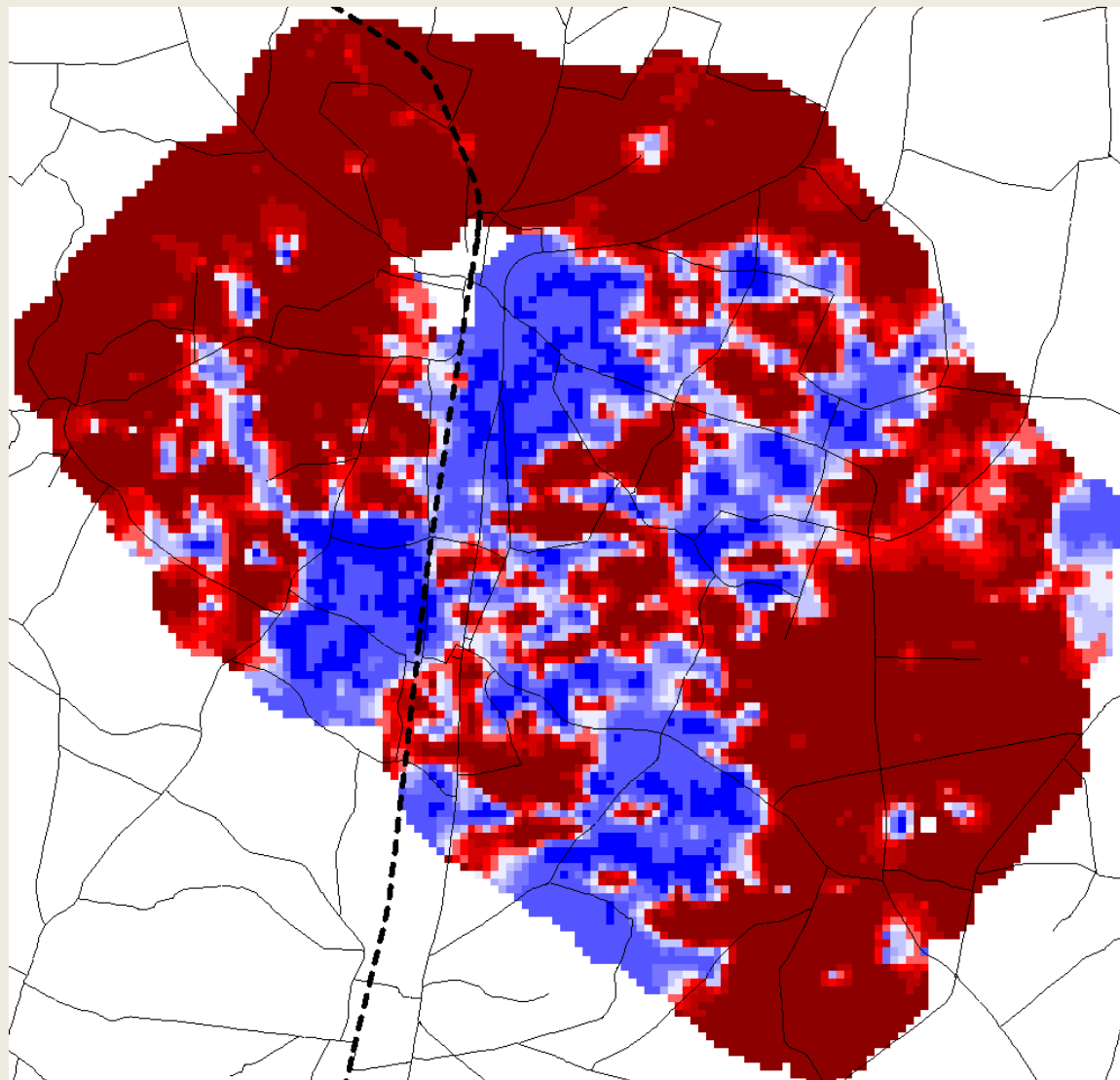


- *How do we reconstruct the 3D geological/hydrogeological model using these data sets?*



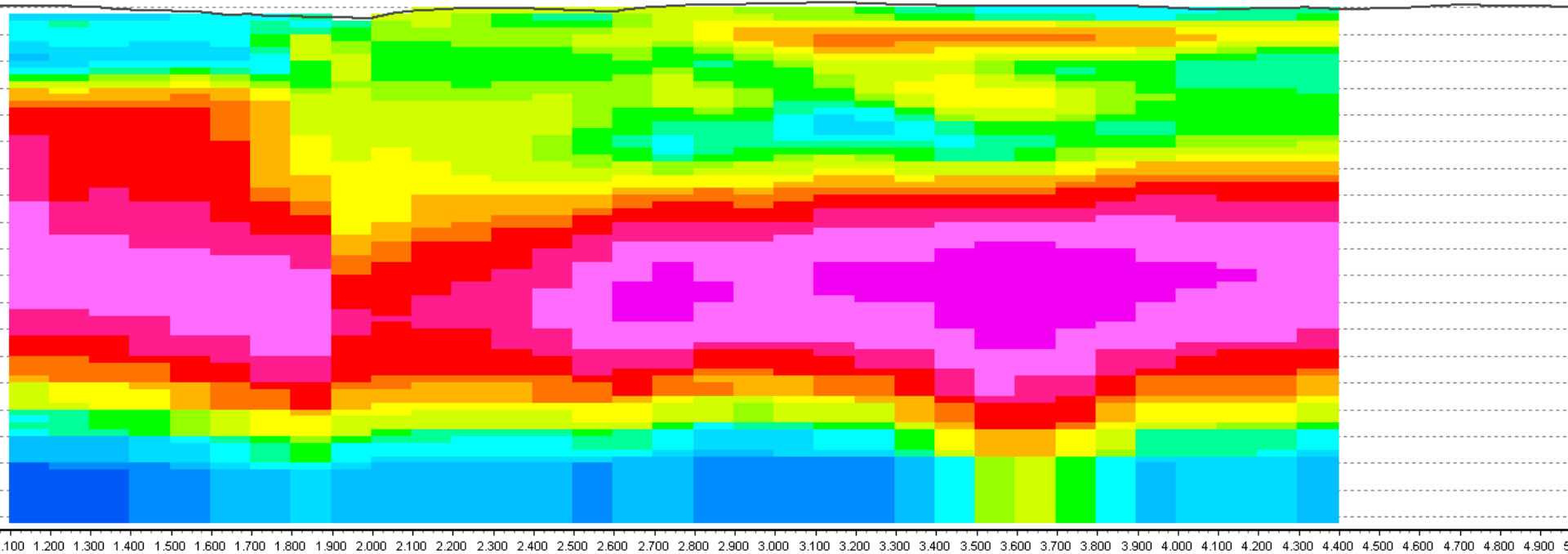
# Conceptually



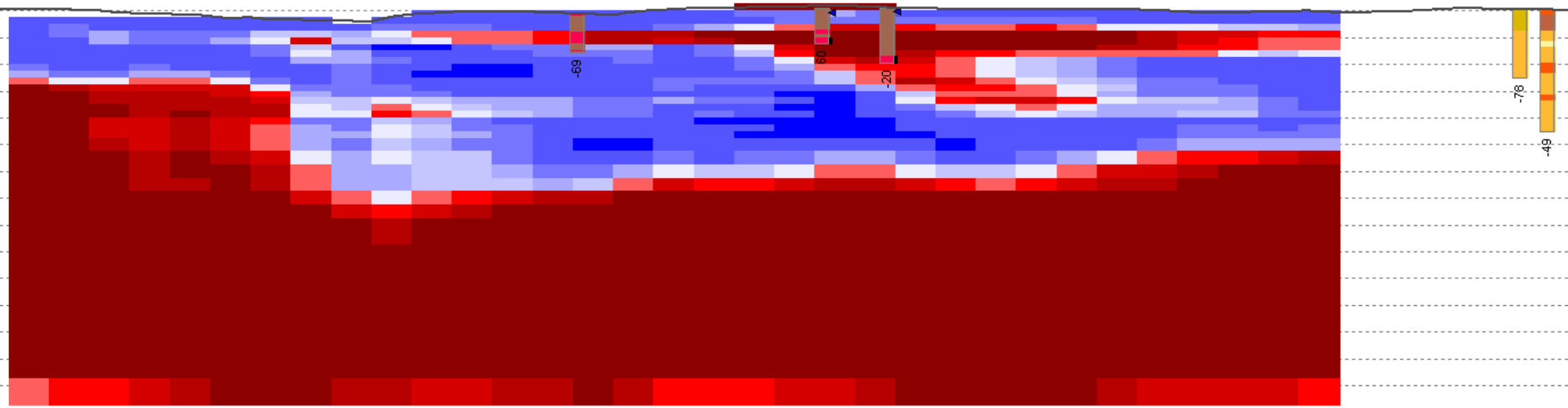




Profile



Profile



1.100 1.200 1.300 1.400 1.500 1.600 1.700 1.800 1.900 2.000 2.100 2.200 2.300 2.400 2.500 2.600 2.700 2.800 2.900 3.000 3.100 3.200 3.300 3.400 3.500 3.600 3.700 3.800 3.900 4.000 4.100 4.200 4.300 4.400 4.500 4.600 4.700 4.800 4.900

