

Geological modeling, uncertainty analysis for site investigation, and online GIS solutions

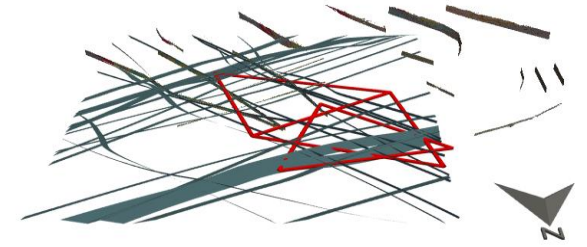
RWTH Aachen

E-TEST TEAM

ET - Site Studies and Characterization Workshop

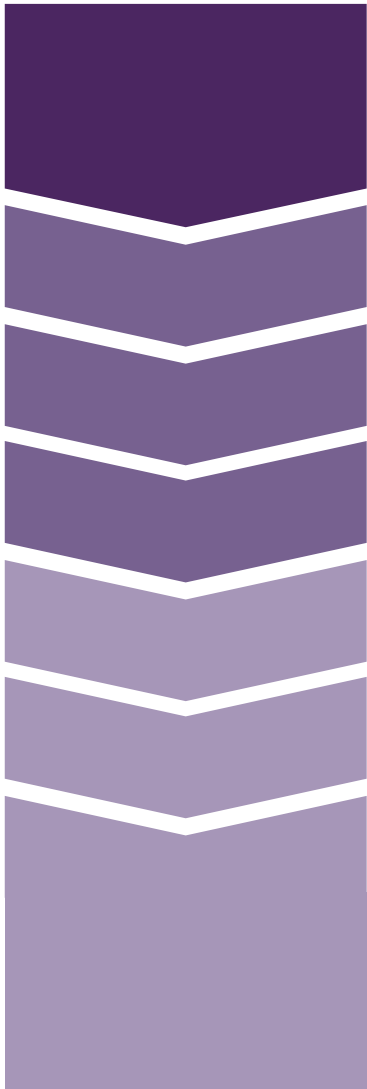
Nils Chudalla, Marius Waldvogel, Raphael Burchartz, Pooya Hamdi , Florian Wellmann

Geological modeling in E-Test



Goal: Find the optimal position for the Einstein Telescope in the subsurface

- Collect & homogenize available data
- Understand tectonic setting
- Preliminary geological models
- Conduct further geophysical exploration
- Refine geological models
- Simulate and plan tunneling



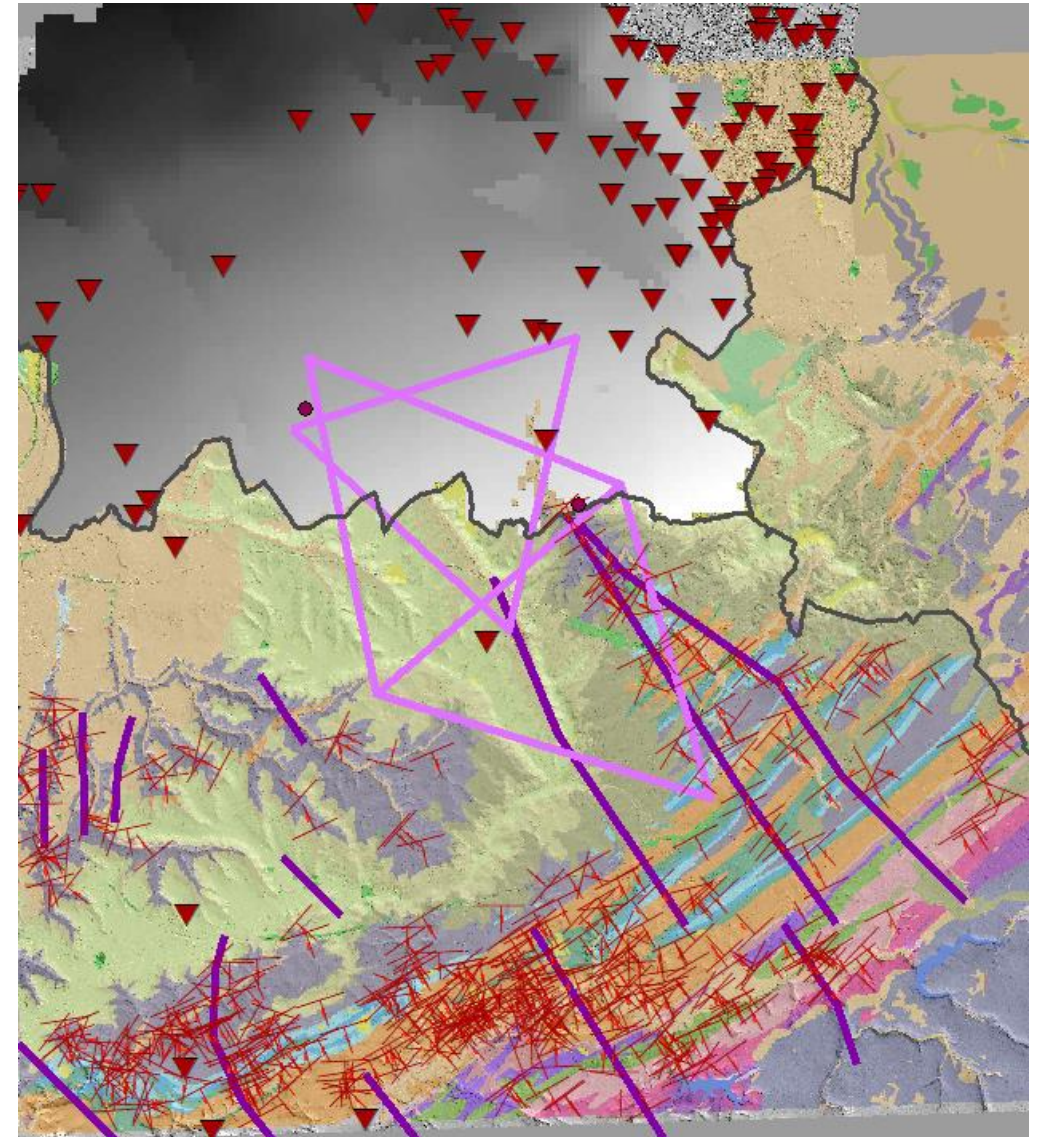
Model input

Main sources of information:

- Boreholes
- Maps (orientations and surface points)
- Profiles
- Seismic interpretations

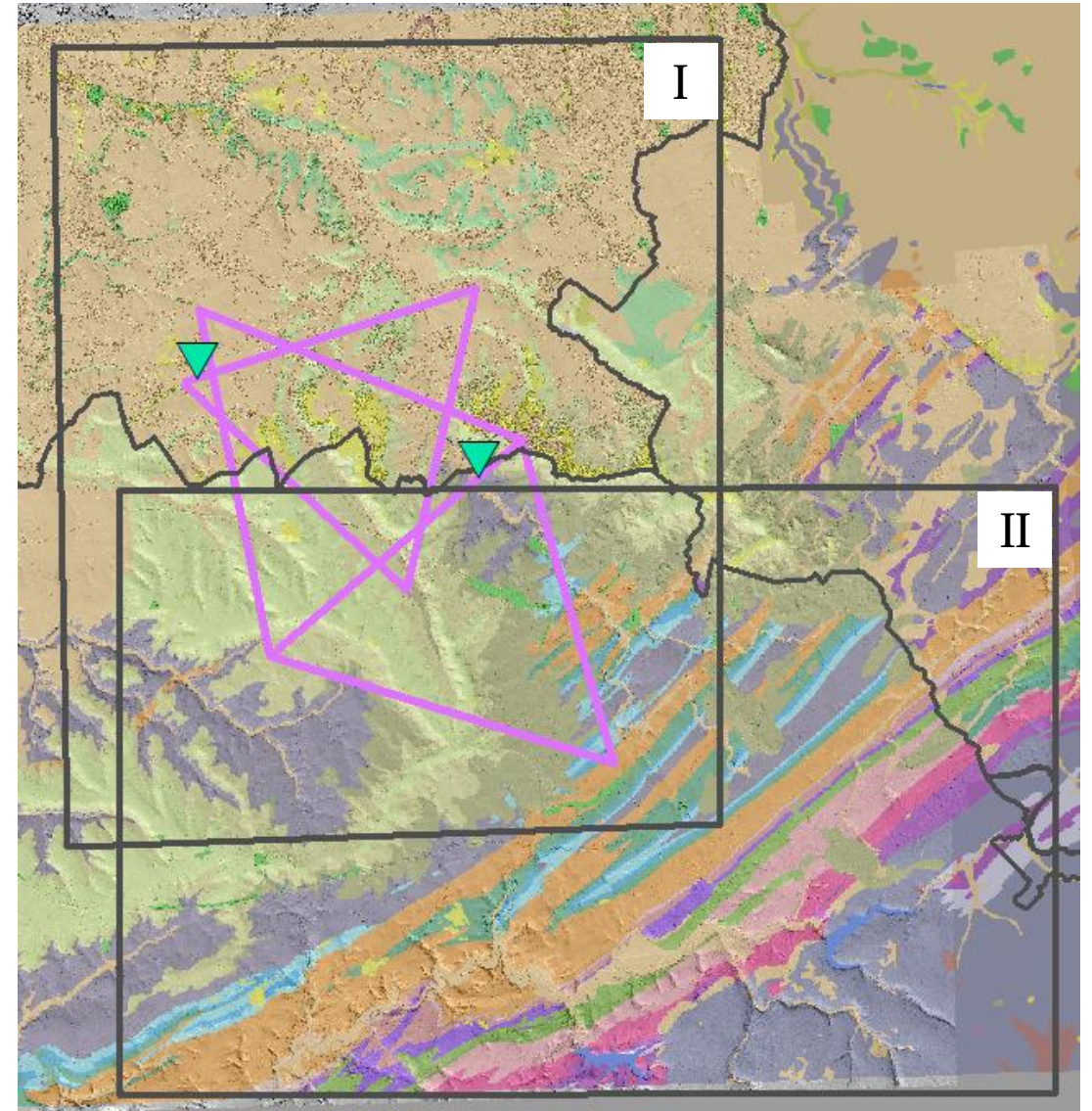
Soon to be acquired:

- Additional boreholes
- 2D seismic
- Passive seismic
- Geophysical methods



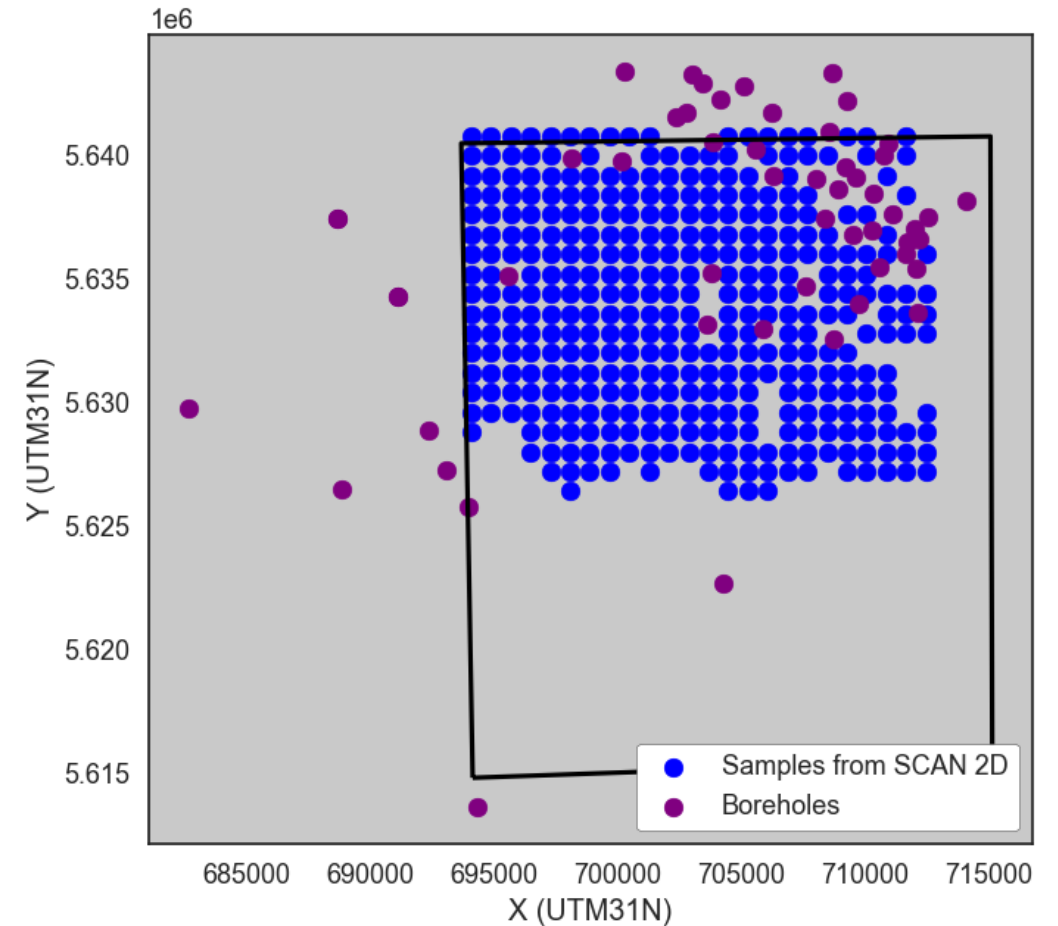
EMR models

- I: Cretaceous Cover
 - Important dampening layer
 - Unconformity (Future drilling operations)
- II: Paleozoic folds and thrusts
 - Contains target layer for tunneling
 - Fault and fracture characterization



Model: Cretaceous cover

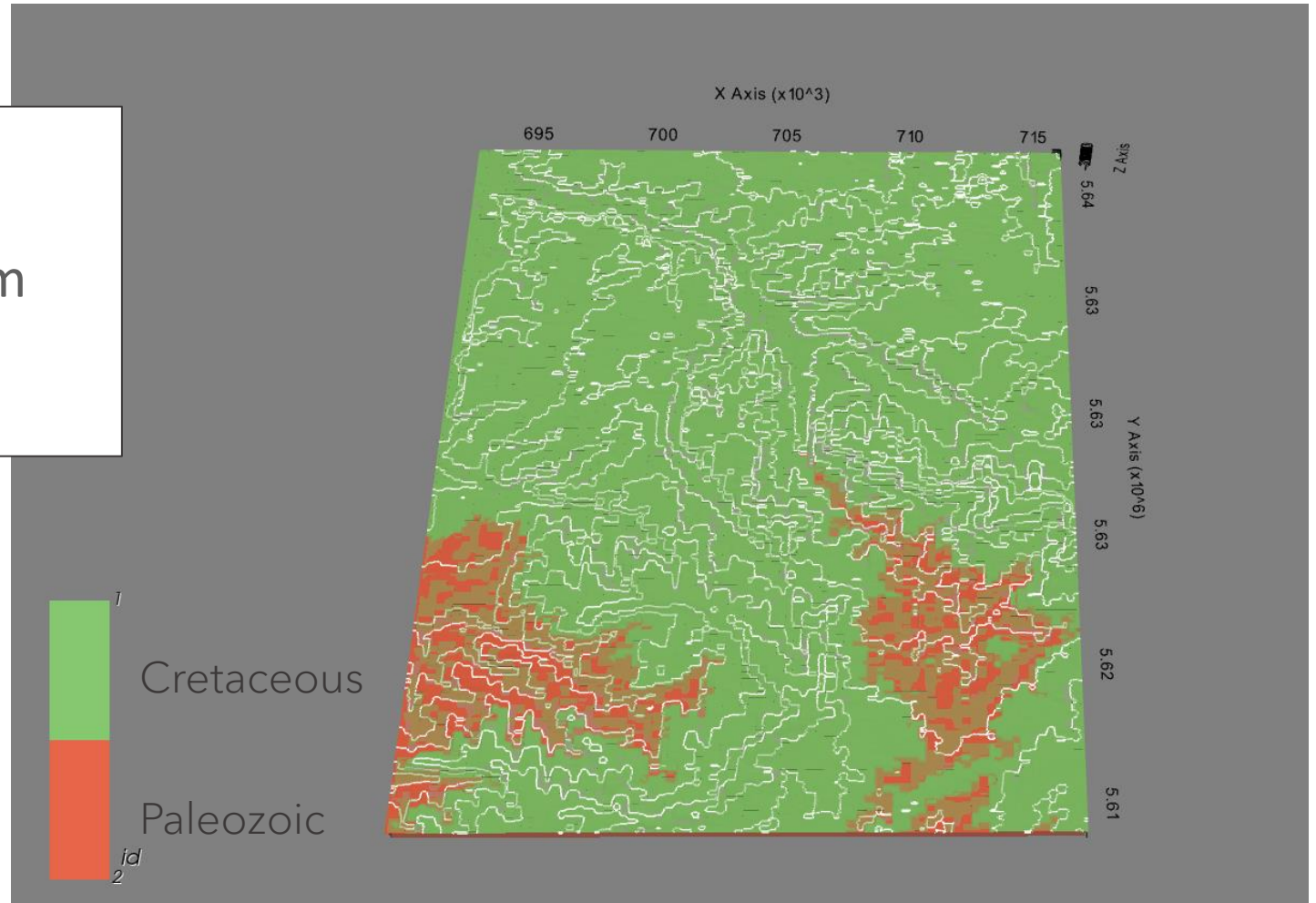
- Status quo:
 - No orientations from outcrops
 - Plenty of boreholes (North)
 - Low resolution seismic
 - Easy geometry
 - Few faults



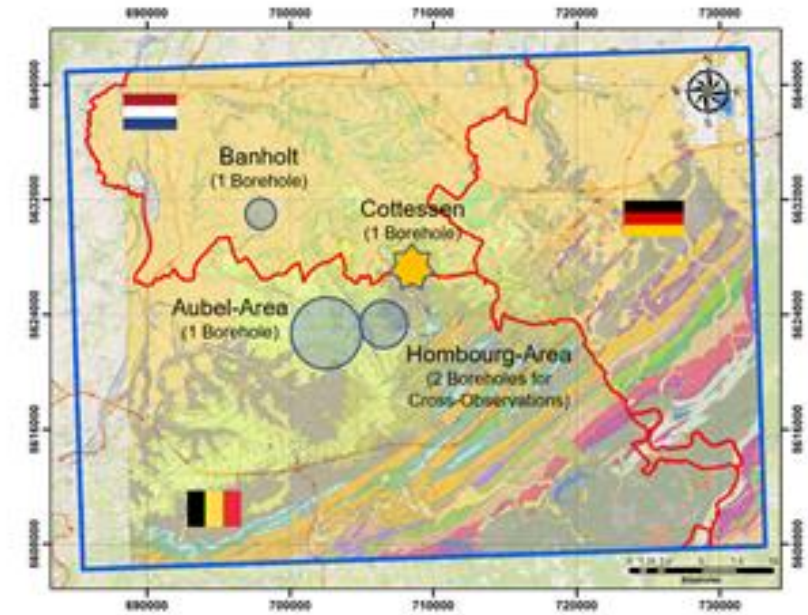
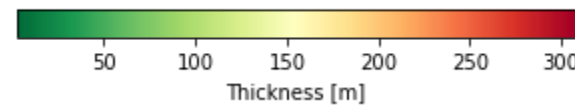
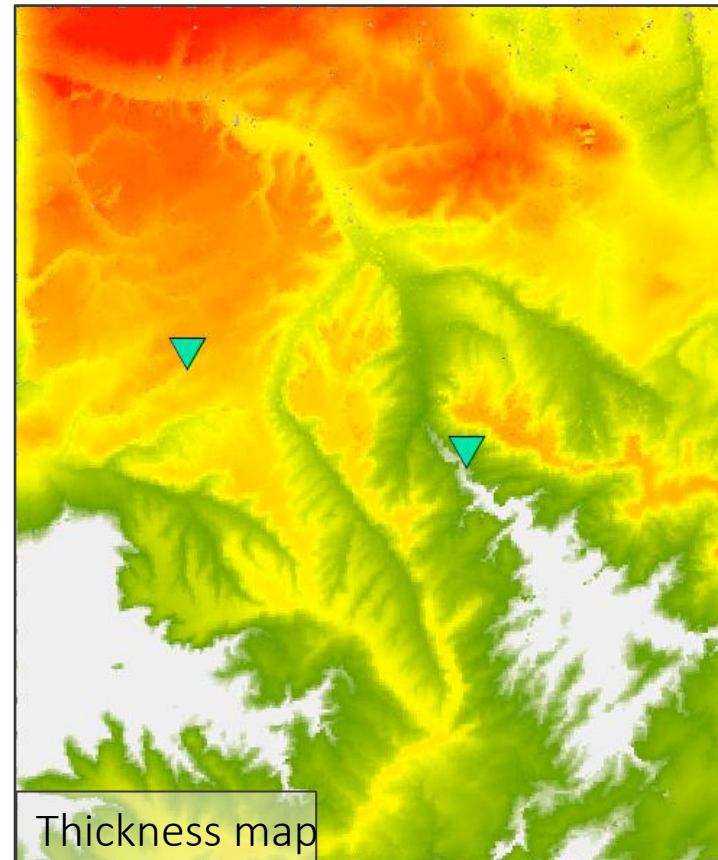
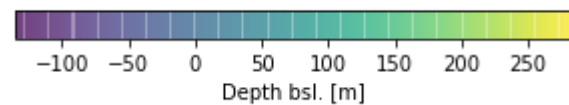
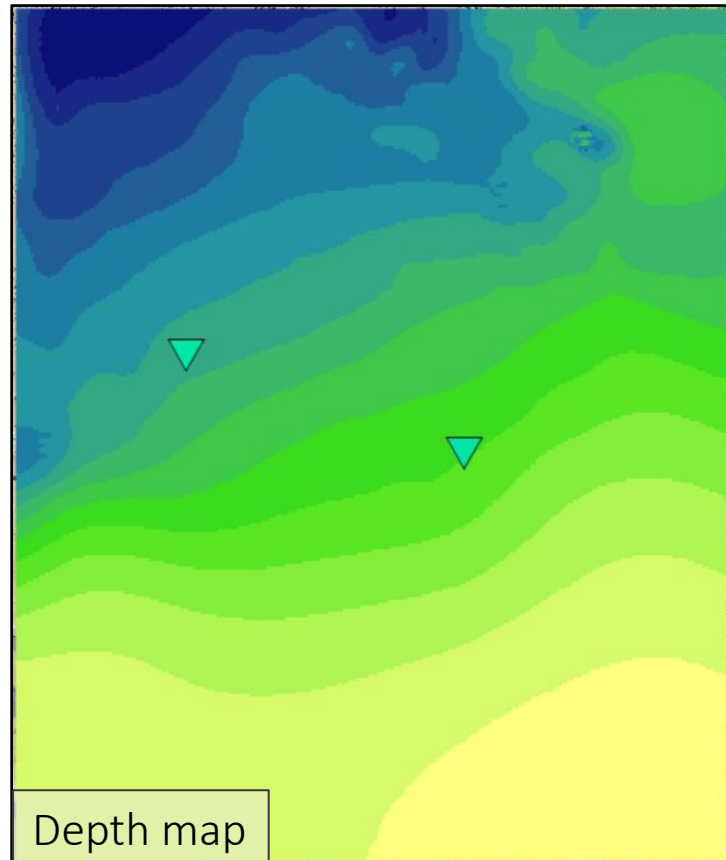
Model: Cretaceous cover

Model dimensions:

- 23,500 x 28,000 x 800 m
- 80 x 120 x 60 blocks



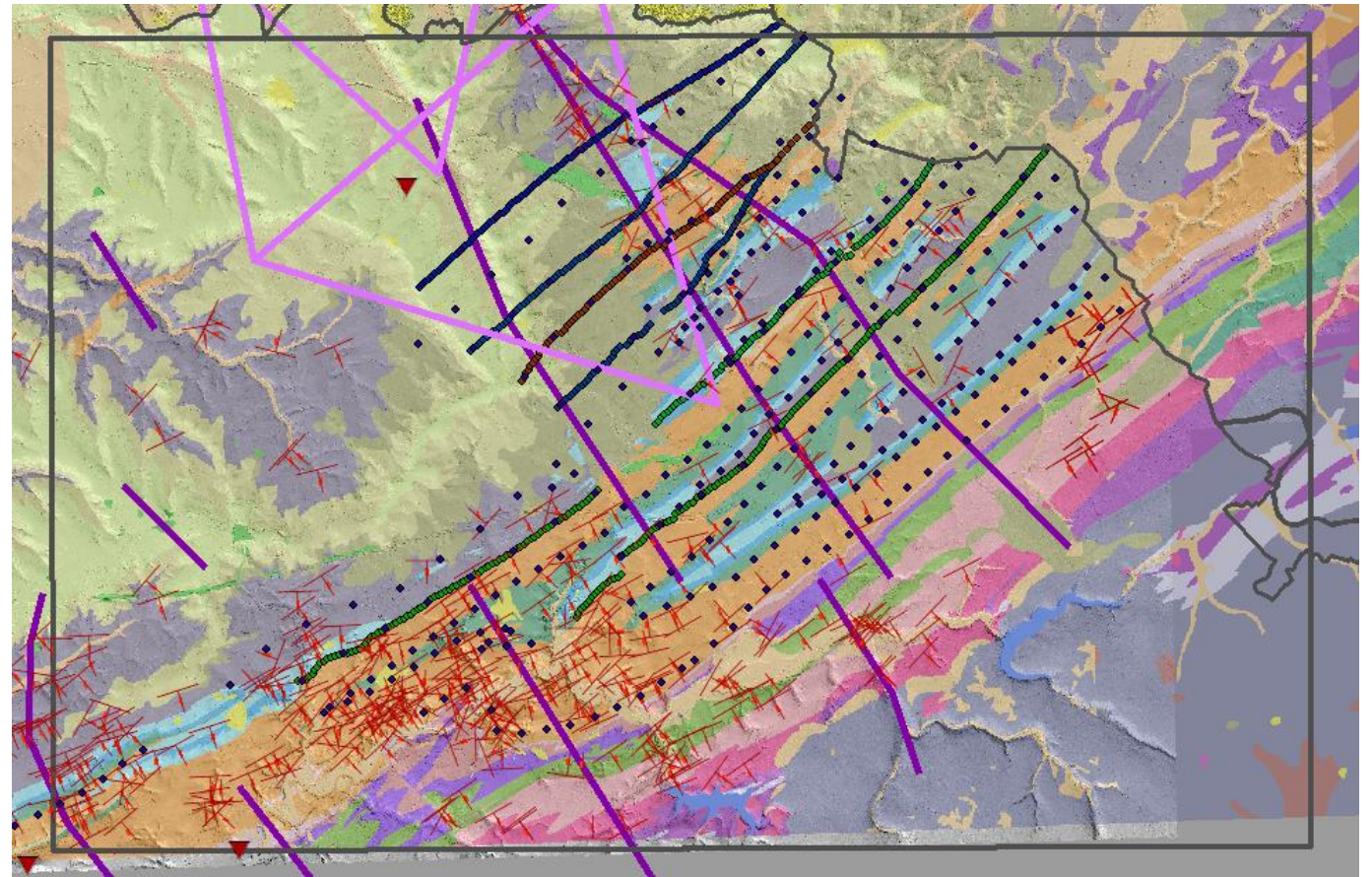
Model: Cretaceous cover



Borehole	Prediction	Measured
<i>Banholt</i>	151 m	130 m
<i>Cottessen</i>	8 m	2 m

Model: Paleozoic folds and thrusts

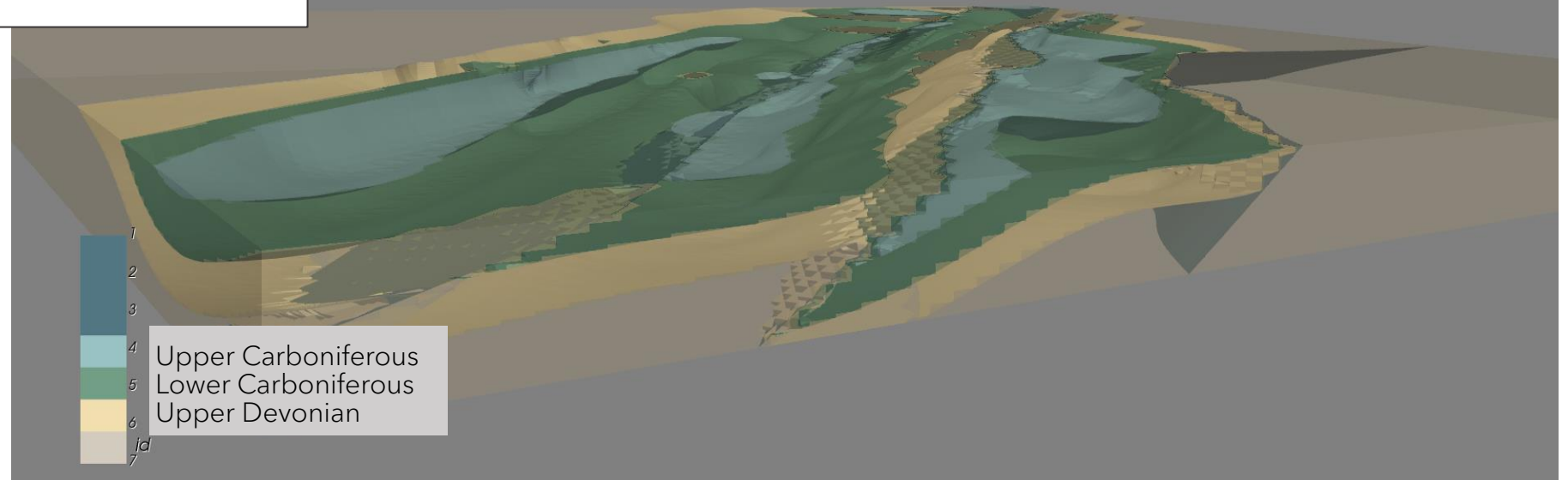
- Status quo:
 - High data density for orientations
 - Few boreholes
 - High structural variability
 - Profile input is based on one specific geological interpretation



Model: Paleozoic folds and thrusts

Model dimensions:

- 19,000 x 14,000 x 800 m
- 80 x 70 x 30 blocks



Uncertainty modeling

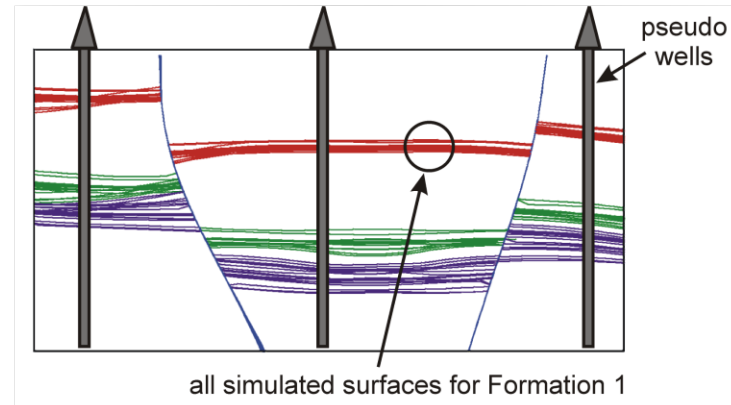
Cretaceous cover

SCAN 2D

Z : 40 m

Boreholes

Z : 10 m



(Wellmann & Caumon, 2018)

Paleozoic folds and thrusts

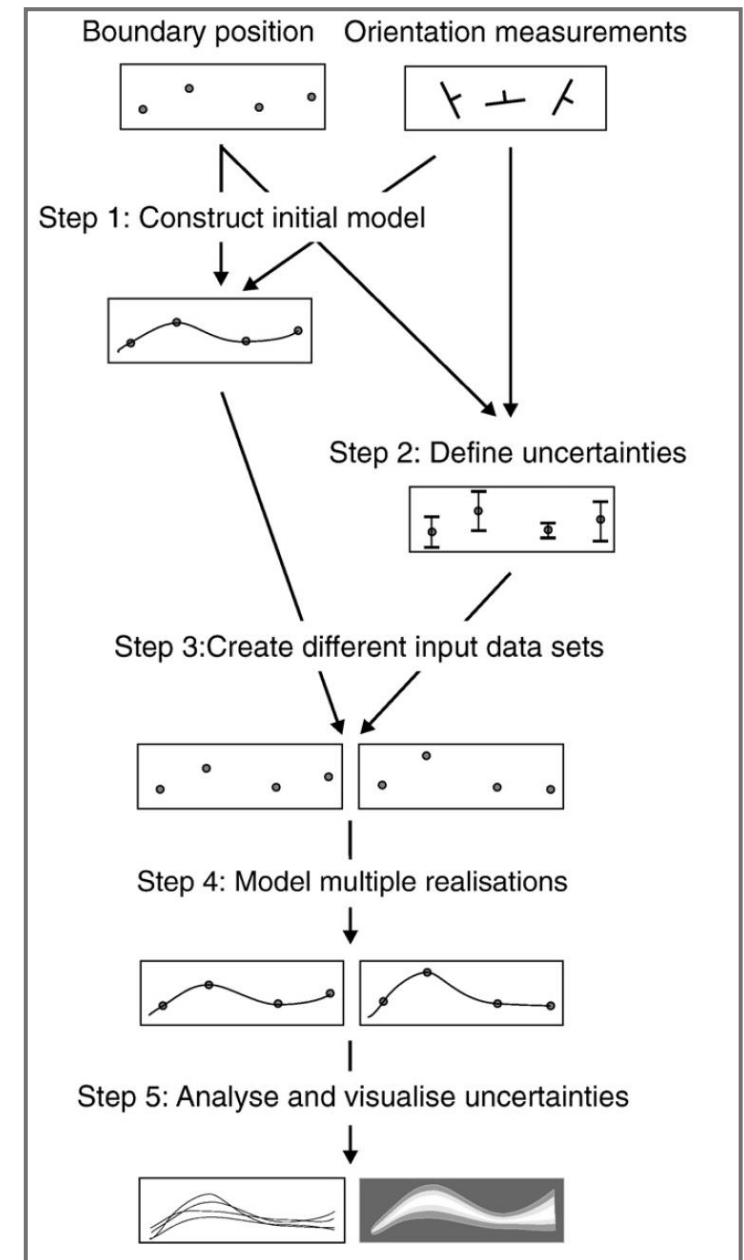
X, Y : 100 m

Z : 25 m

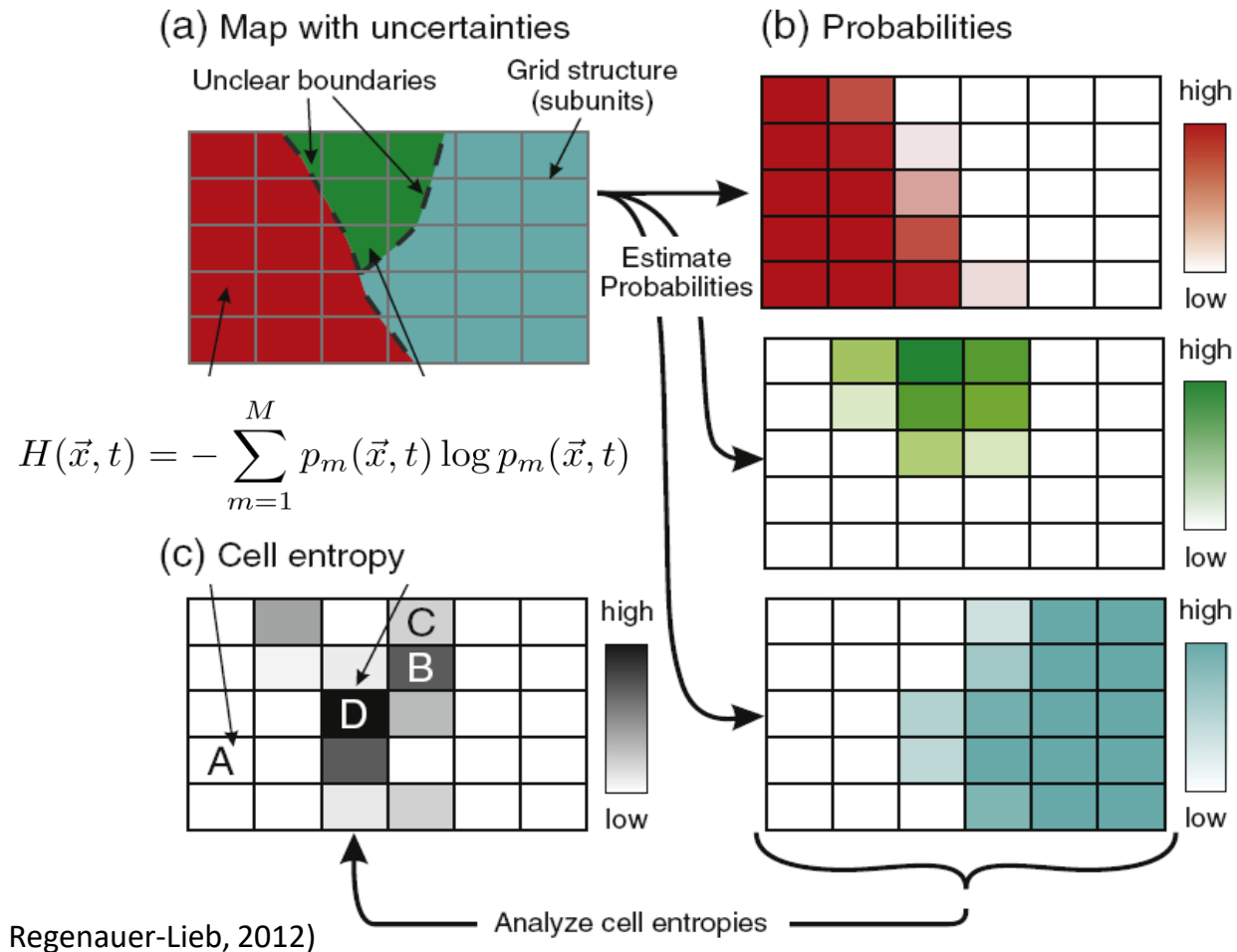
Dip : 10 °

Azimuth : 10 °

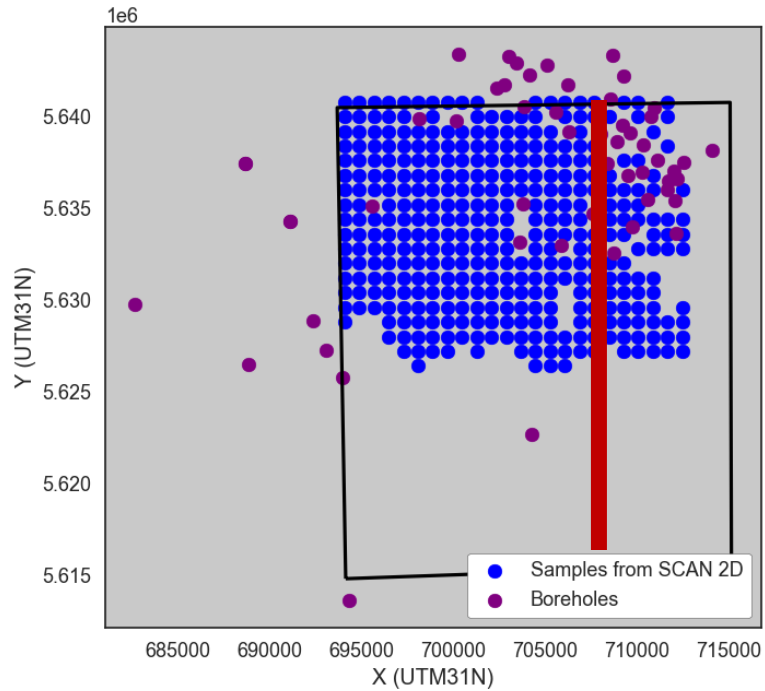
These are only assumptions based, a clear quantification is planned.



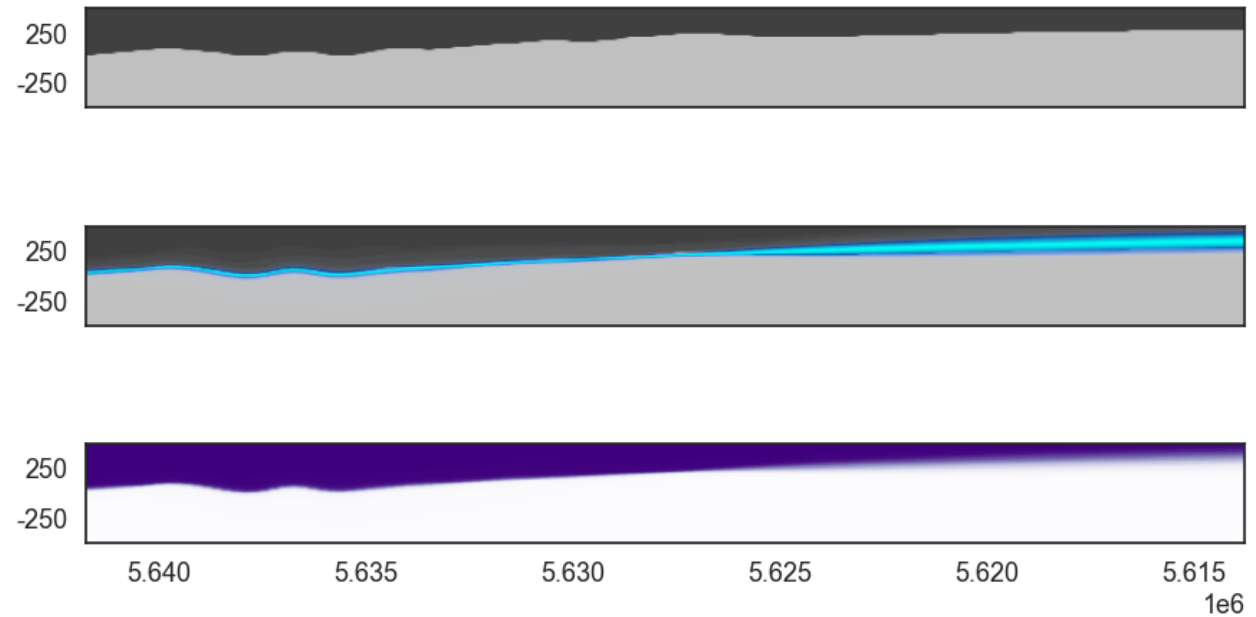
Uncertainty and Shannon cell Entropy



Uncertainty: Cretaceous cover

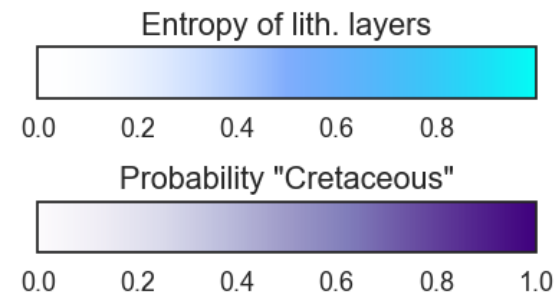


Cross section in model

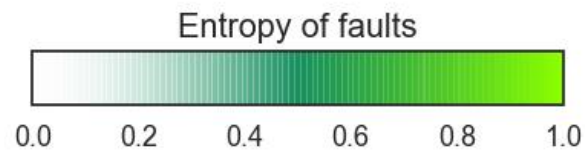
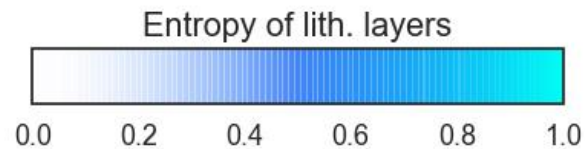
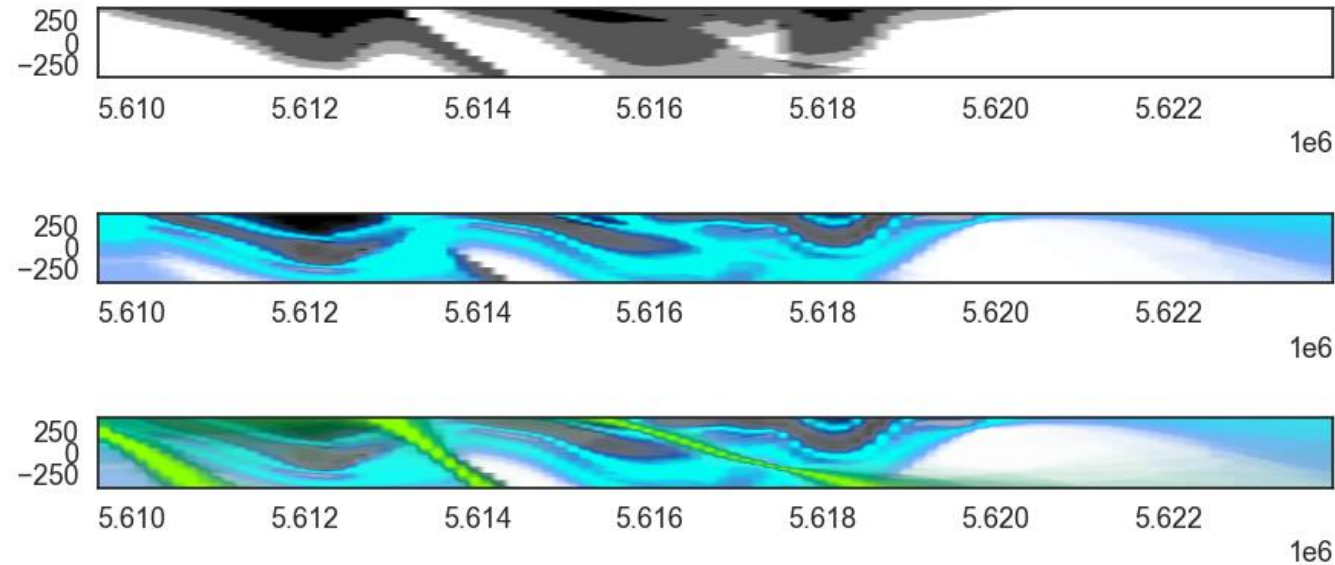


Explore it!

Streamlit



Uncertainty: Paleozoic folds and thrusts



Geological modeling: Challenges & Opportunities

Challenges:

- Quantify error of model input
- Reduce overall uncertainty
- Model different geological interpretations
- Maximize information from available data

Opportunities

- Evaluate model quality and geological interpretations
- Maximize information gain from exploration methods

Online GIS solutions

“Isn’t there data somewhere on that topic?”

- Large amounts of data collected and homogenized
- Large amounts of data generated
- Many researchers and (future) ET2SME partners involved
- Public outreach

Online data platform

What is geological data? What should it do?

Data input:

- Boreholes (Points, bar diagrams)
- Geological features, e.g. faults (Polylines)
- Geophysical methods, e.g. ERT (Polylines, images)
- Spatial interpolations (Raster images)
- 3D geological models (3D objects)
- ...

Functionality:

- Filter data
- Select data
- Download data
- Locate the right data (Intuitive interface)

Online Geology

UmweltAtlas Angewandte Geologie

Inhalt Suche

Meine Inhalte

Inhalt

- Georisk-Objekte
- Anbruchbereiche
- Ablagerungsbereiche
- Gefahrenhinweiskarten
 - Steinschlag/Blockschlag mit Walddämpfung
 - Steinschlag/Blockschlag ohne Walddämpfung/Felssturz
 - Tiefreichende Rutschung
 - Rutschanfälligkeit
 - Anfälligkeit für flachgründige Hanganbrüche
 - Anfälligkeit für flachgründige Hanganbrüche im Extremfall
 - Erdfälle/Dolinen
 - Großflächige Senkungsgebiete
- Permafrostwahrscheinlichkeit
- Geologie erleben
 - Geotope
 - Geo- und Bodenlehrpfade
 - GeoUntertage
 - GeoMuseen
 - Via GeoAlpina

Themen

Erdwärmekollektoren

Geothermische Ergiebigkeit

Erdwärmesonden

40 m Sondenlänge

60 m Sondenlänge

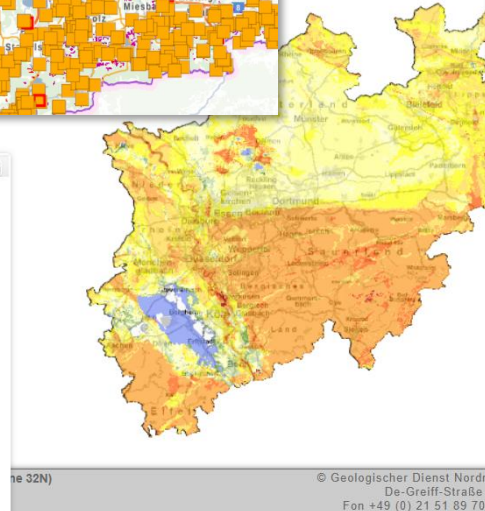
80 m Sondenlänge

100 m Sondenlänge

Hydrogeologisch kritische Bereiche

Wasser- und Heilquellenschutzgebiete

weitere Bereiche (nur Erdwärmesonden)



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
In Zusammenarbeit mit den Kantonen

Ort suchen oder Karte hinzufügen:
z.B. Bundesplatz 1 Bern, 46.7 7.5, Lärmkarte ...

Teilen

Erweiterte Werkzeuge

Geokatalog Thema wechseln

Dargestellte Karten

Geografische Namen swissNAMES3D

SWISSIMAGE Zeitreise **Aktuell**

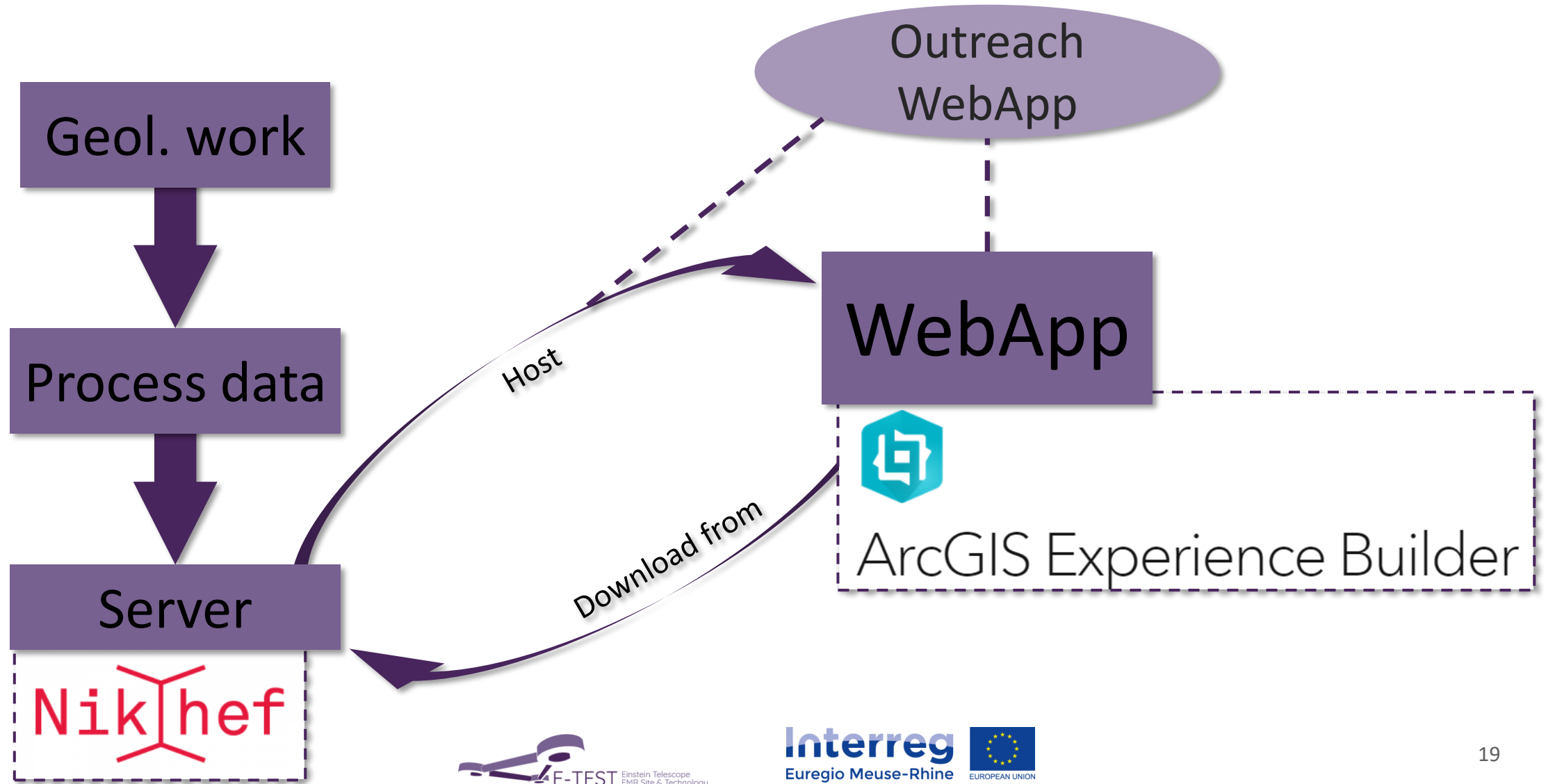
Nach weiteren Karten suchen?

Menü schliessen

Wichtiger Hinweis: 3D-Daten nicht aktualisiert / 2D-Daten in 3D

Geologischer Dienst NRW
Bayrisches Landesamt für Umwelt
SwissTopo

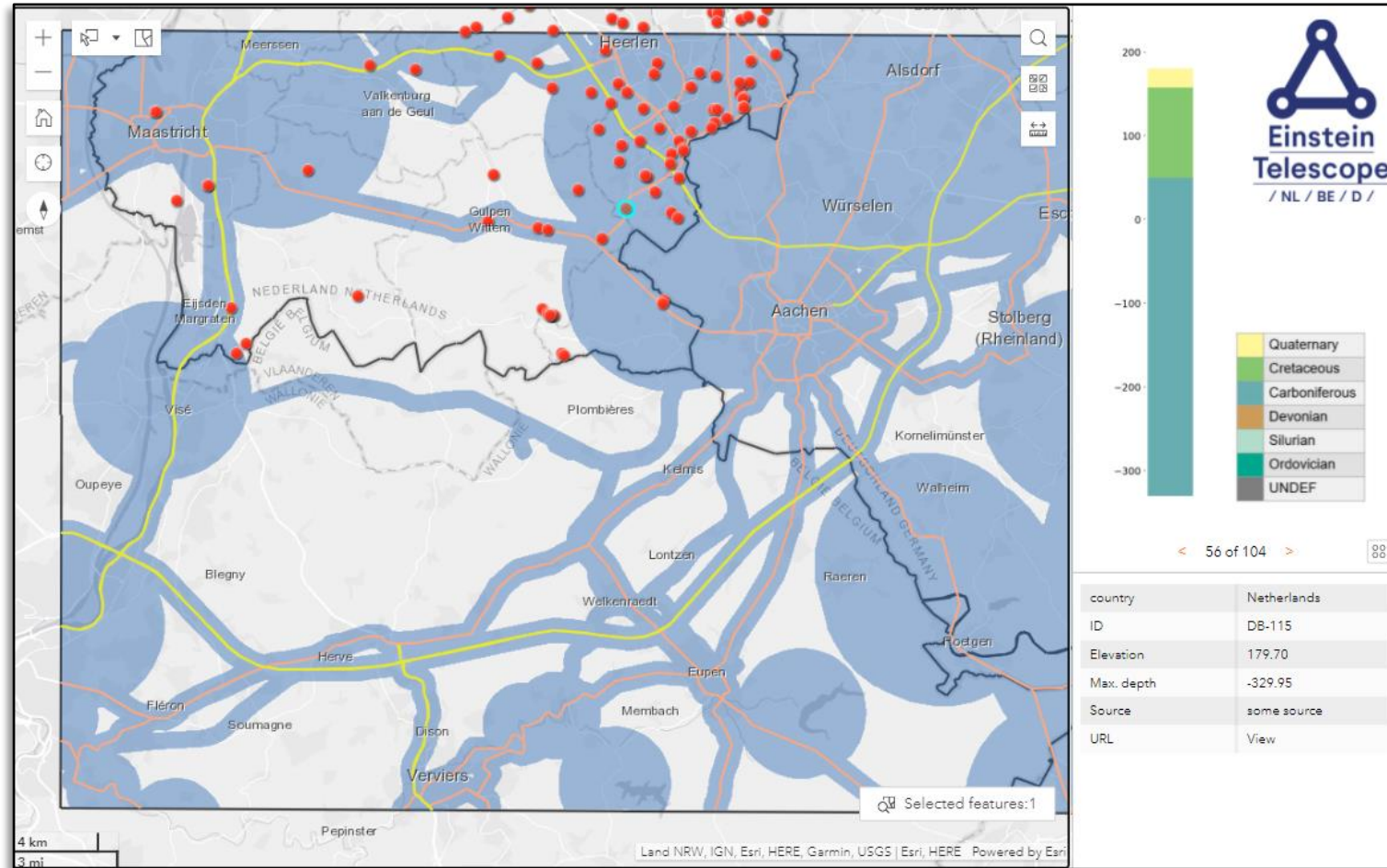
Simplified workflow (How could this work?)



Custom widgets (ArcGIS)



Showcase WebApp





E-TEST is co-funded by the Regions:



Wallonie



VLAAMS-
BRABANT



Ministerium für Wirtschaft, Innovation,
Digitalisierung und Energie
des Landes Nordrhein-Westfalen

provincie limburg



Ministerie van Economische Zaken
en Klimaat



E-TEST is also co-funded by the own-fundings of all Partners:





E-TEST partners





E-TEST Einstein Telescope
EMR Site & Technology

Thank you for
your attention



SCAN ME