EMerald Geomodelling

Unlocking the value of geophysical and geotechnical data through machine learning illustrated by quick clay volume delineation based on airborne geophysics, lab samples and totalsoundings

Andi A Pfaffhuber & Craig Christensen

Quick clays - geological constraints on occurrences

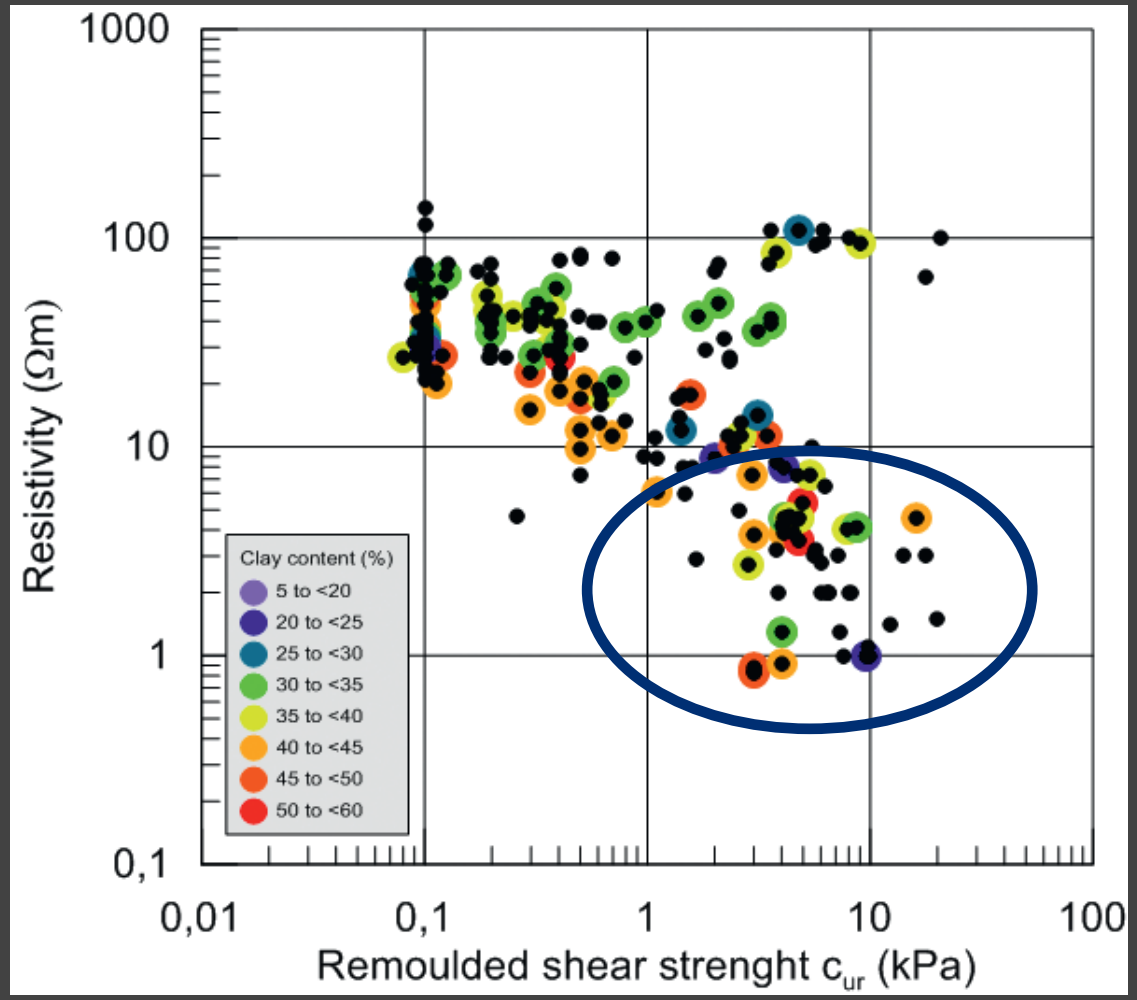
Rosenqvist tribute

Introduction

- Why we need machine learning
- How we use machine learning
- Examples
- Limitations



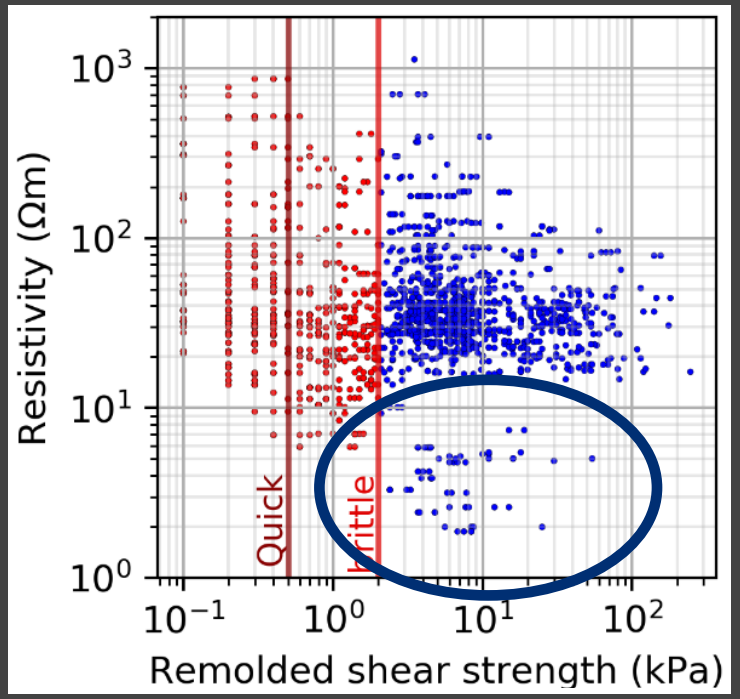
Combining rather than comparing



Long et al. 2017

← *Nation-wide clay samples*

Project-wide soil samples ↘



How we combine



Geophysical data

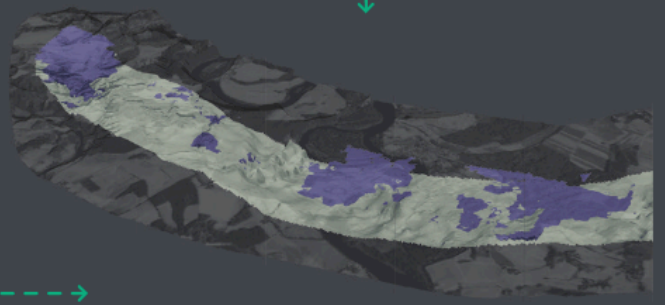


Geotechnical data



Geological data

Machine Learning



Model

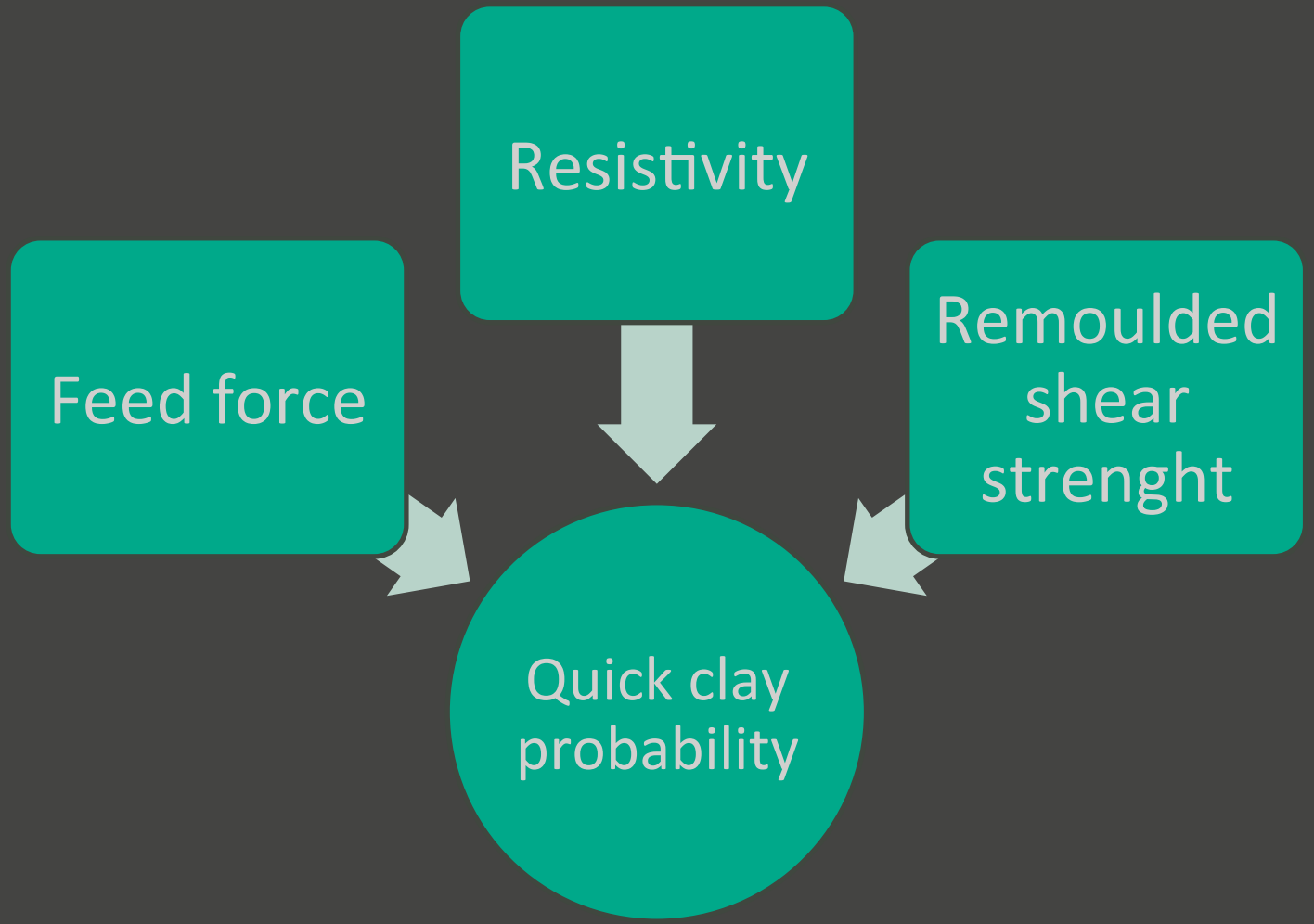


Project owner

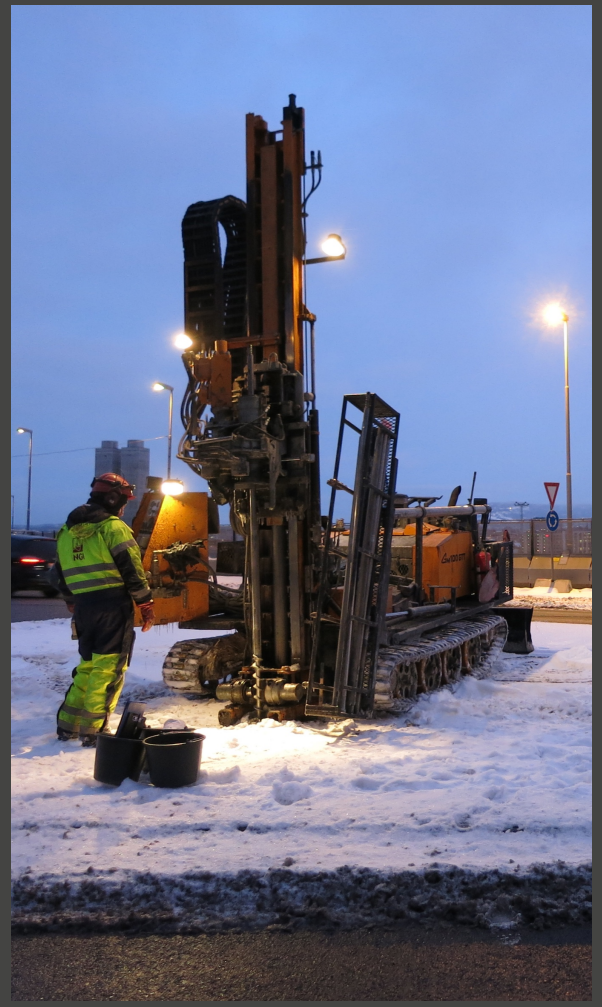


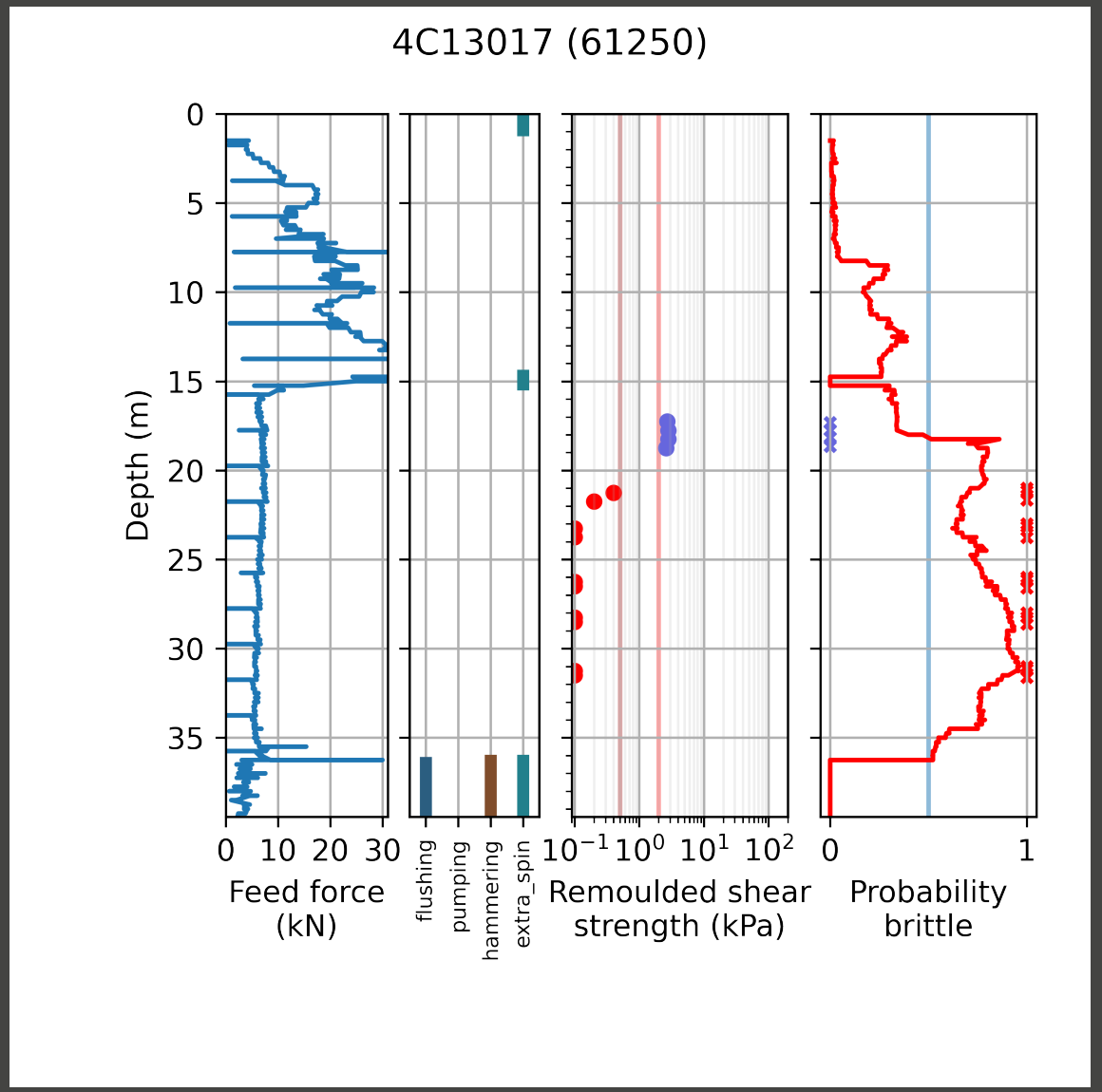
Project engineer

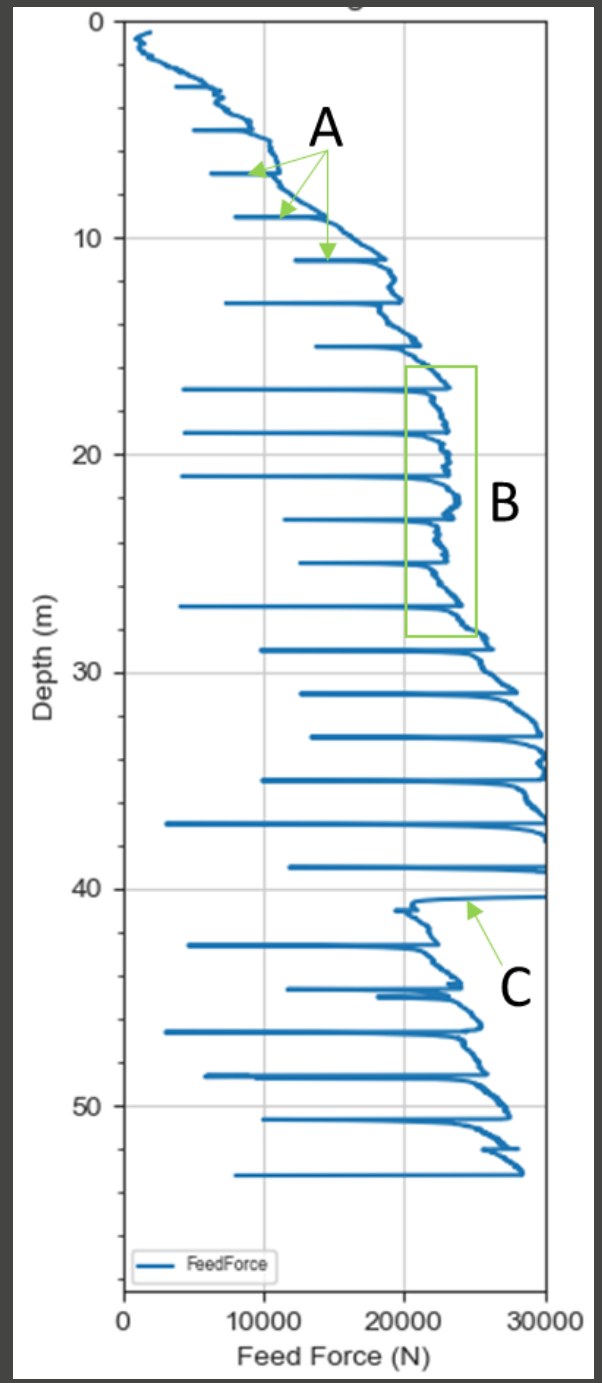
Relevant data towards a quick clay model

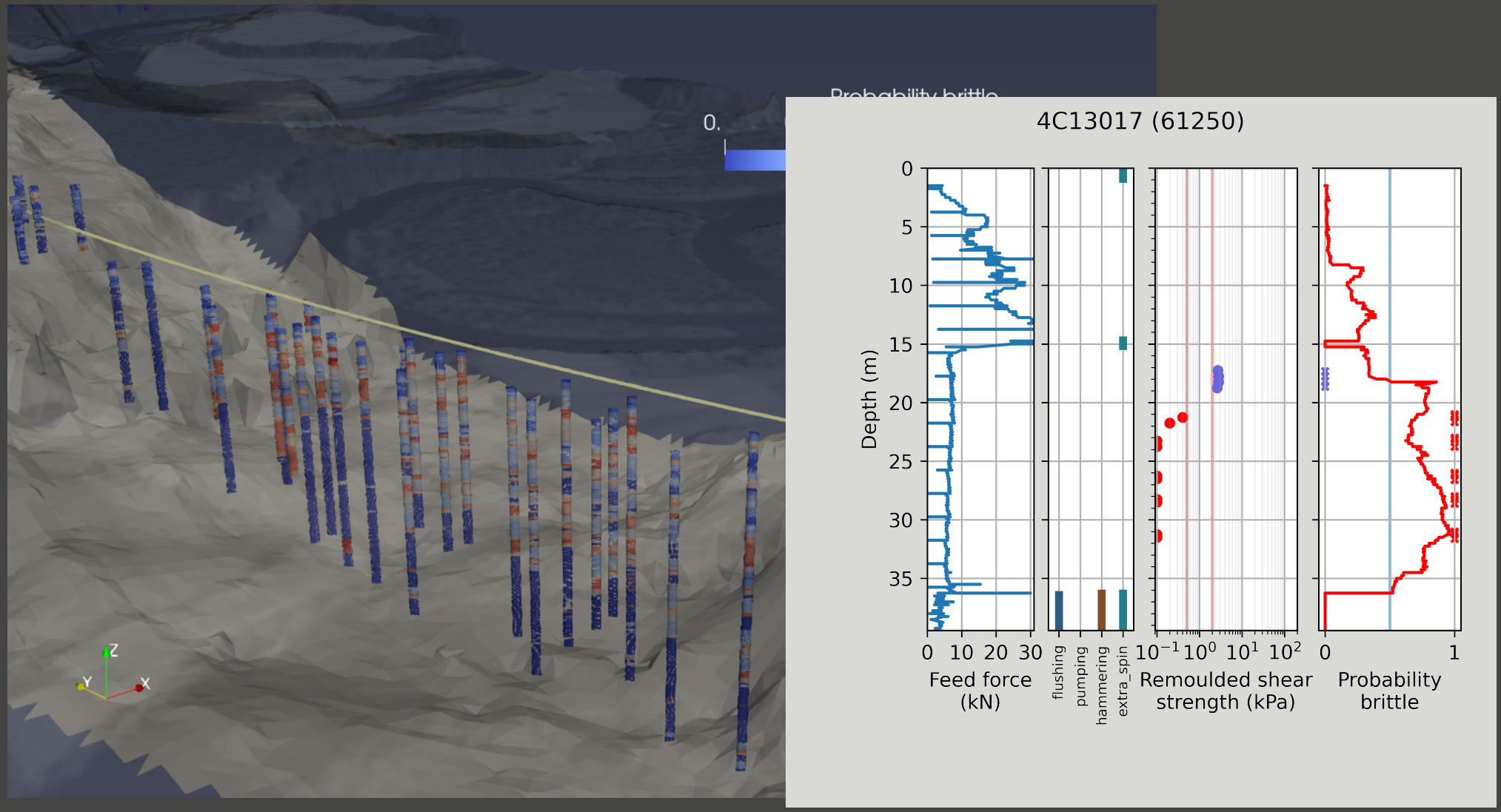


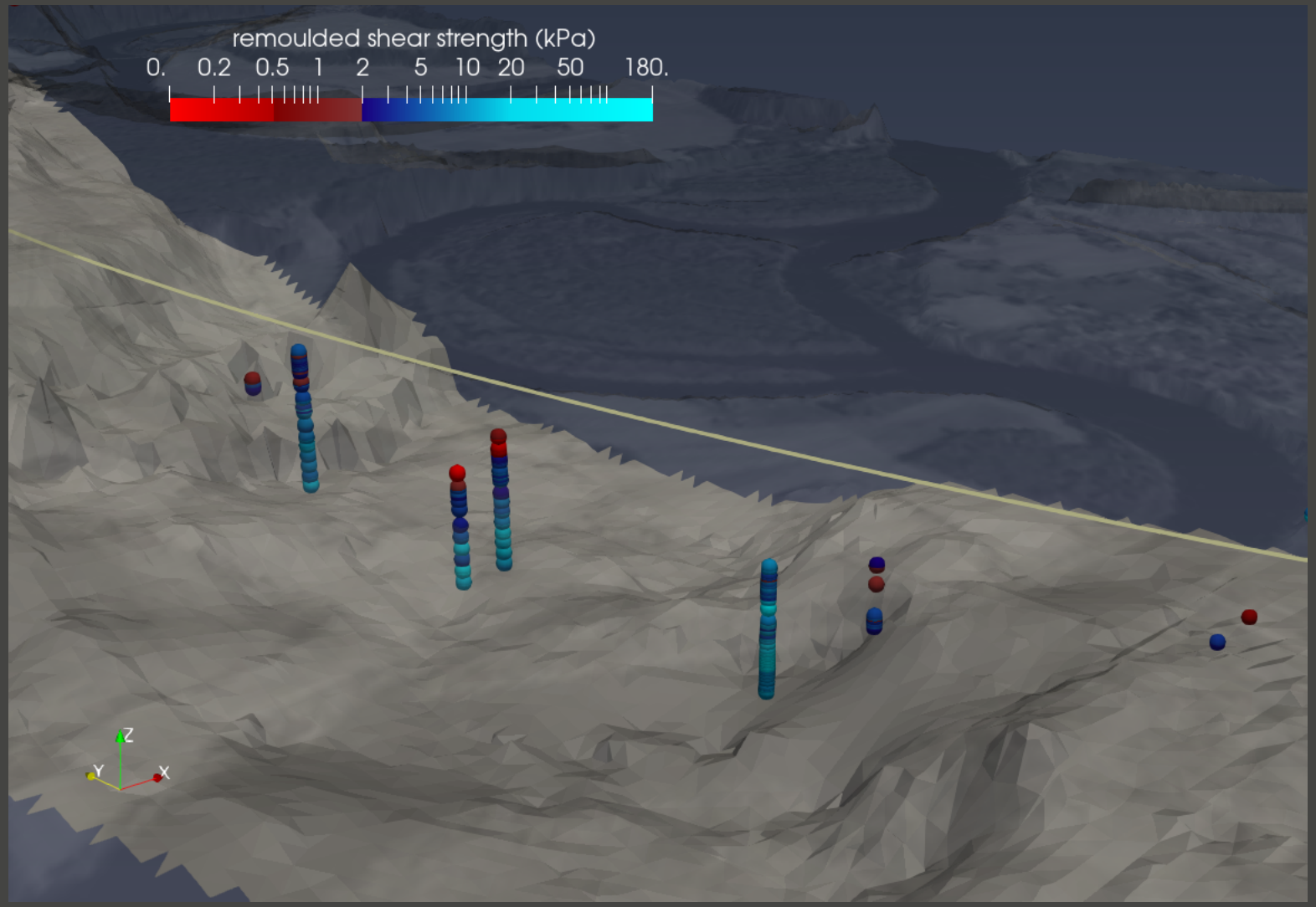
Classifying total soundings



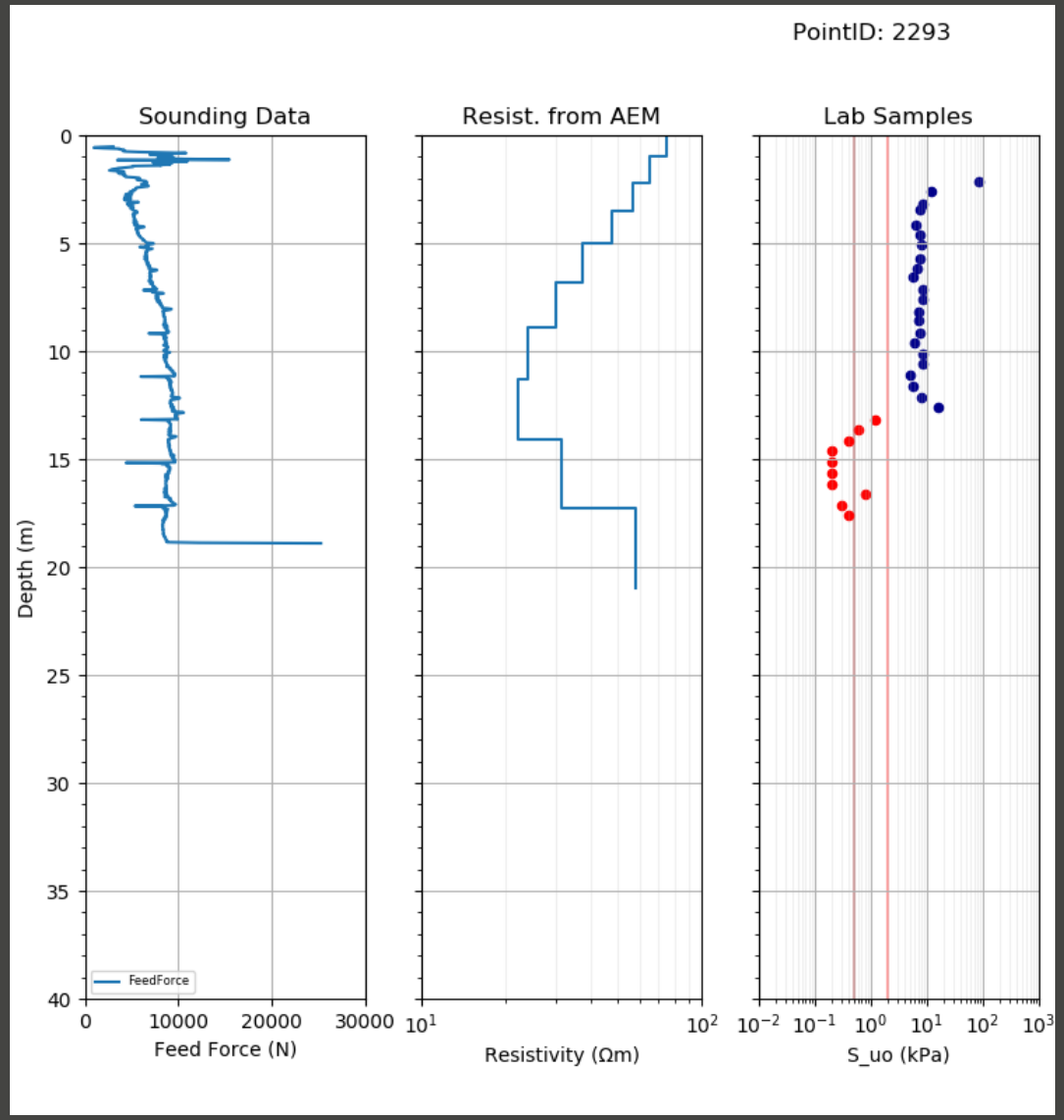


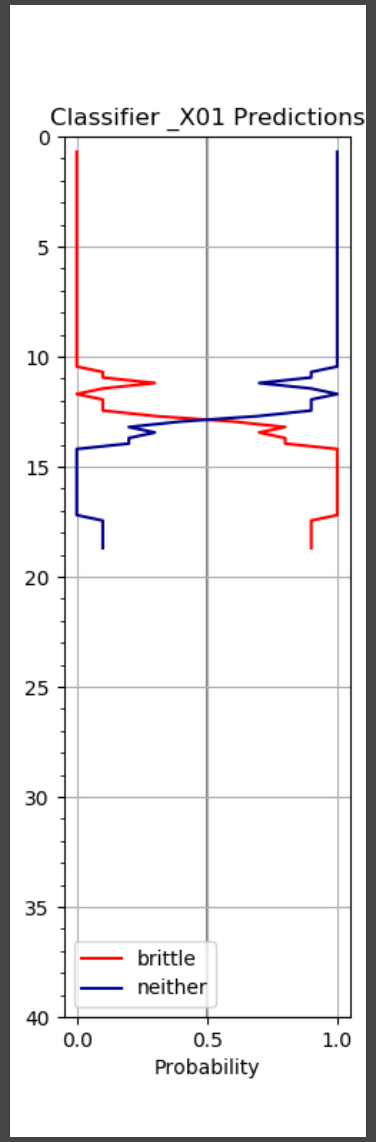


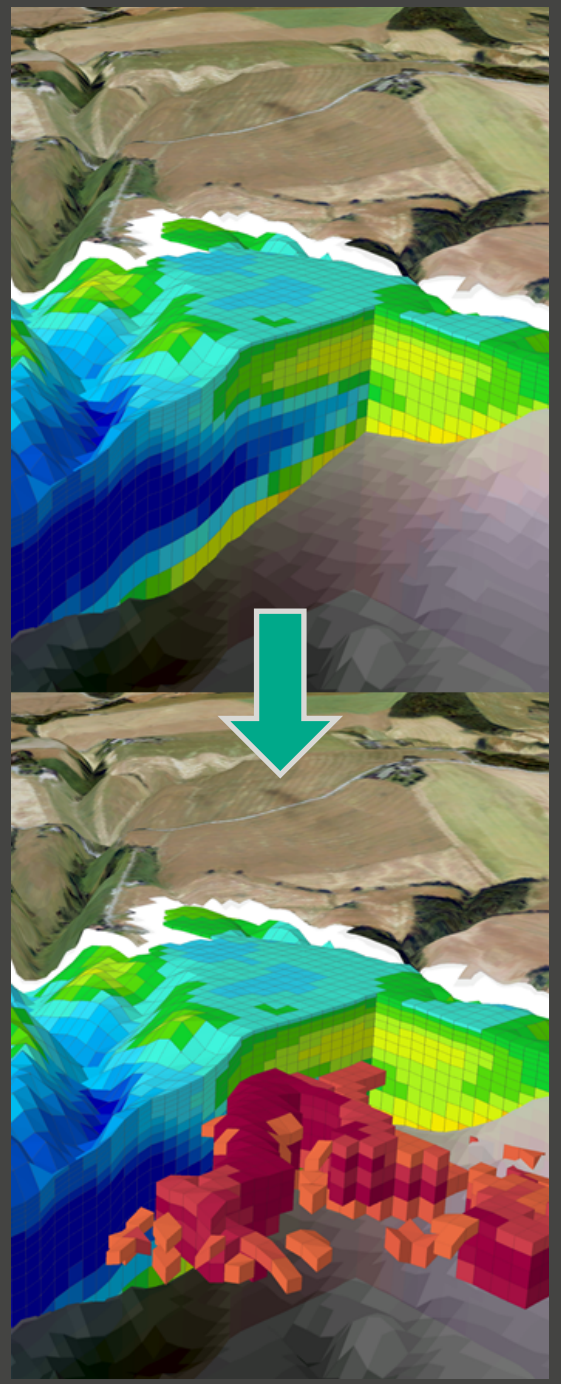

0.
Z
Y
X
4C13017 (61250)
Depth (m)
0
5
10
15
20
25
30
35
0 10 20 30
Feed force (kN)
flushing
pumping
hammering
extra_spin
10^{-1} 10^{0} 10^{1} 10^{2}
Remoulded shear strength (kPa)
0
1
Probability brittle


remoulded shear strength (kPa)
0. 0.2 0.5 1 2 5 10 20 50 180.
Z
Y
X

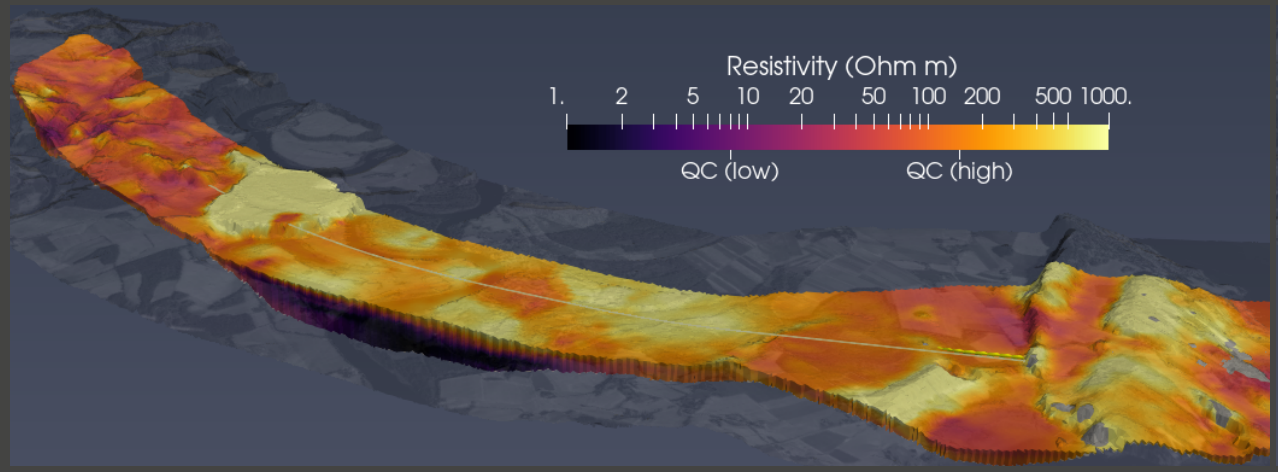
From sample to 3D volume

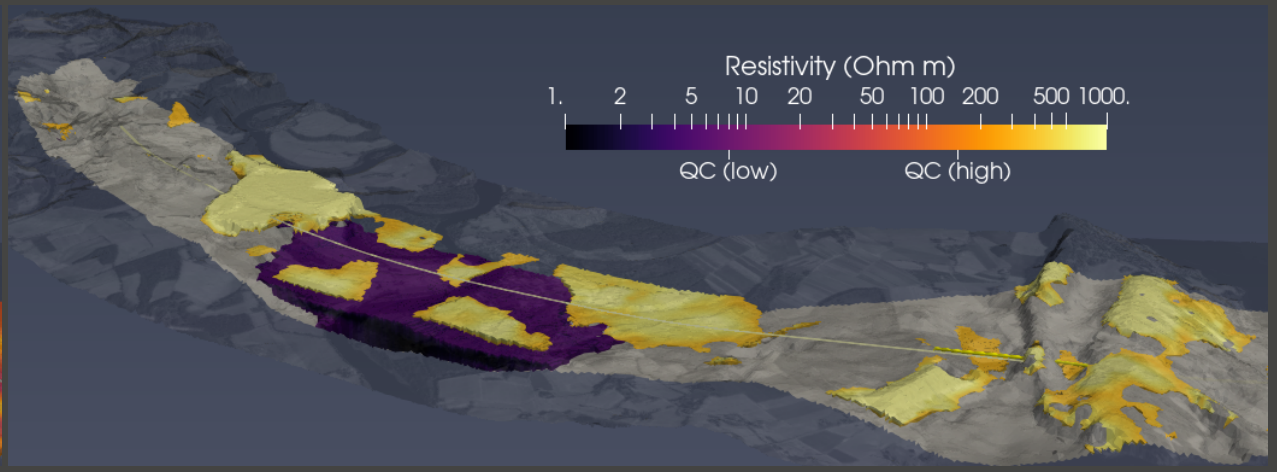


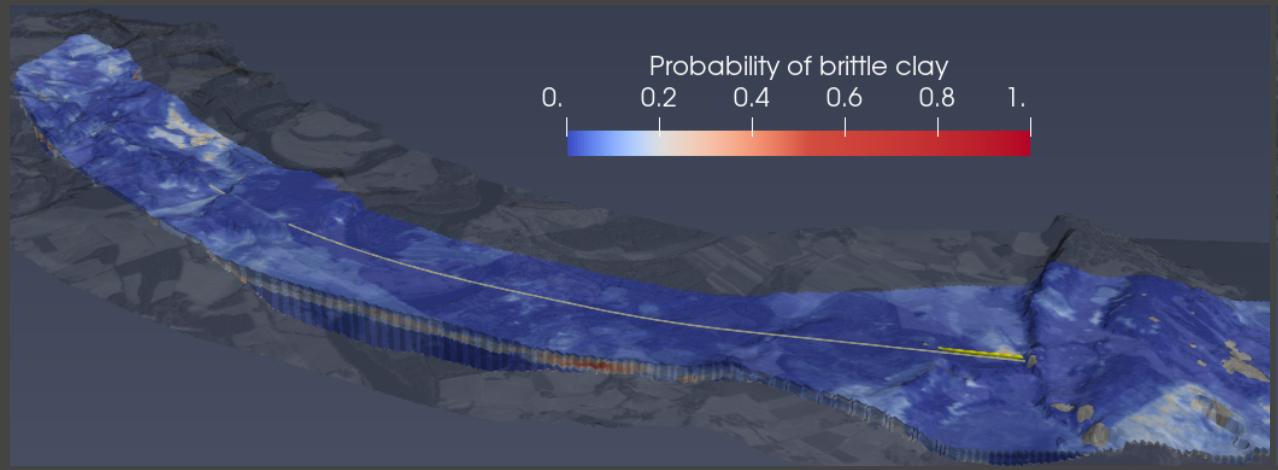


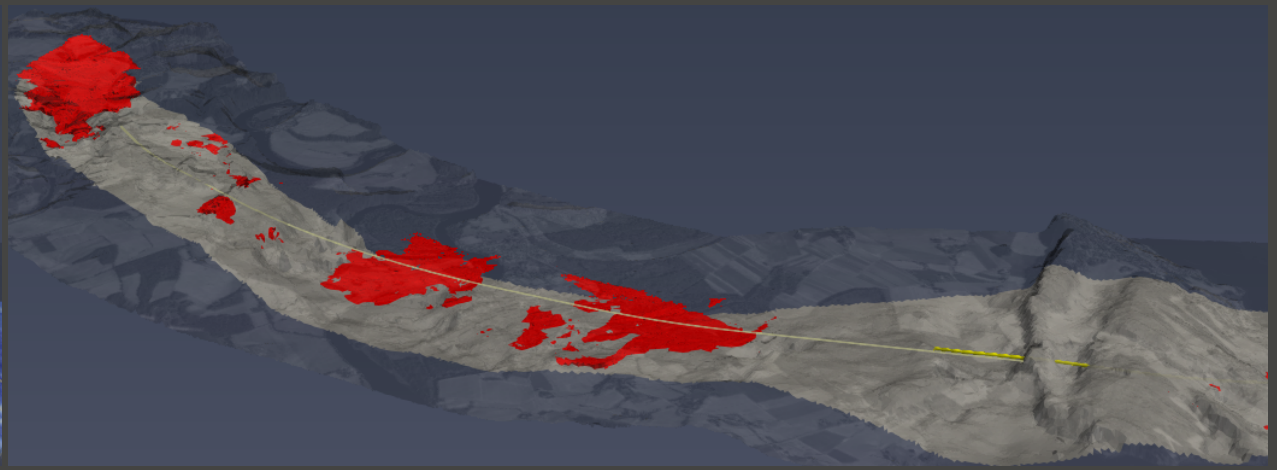


From resistivity to quick clay volume

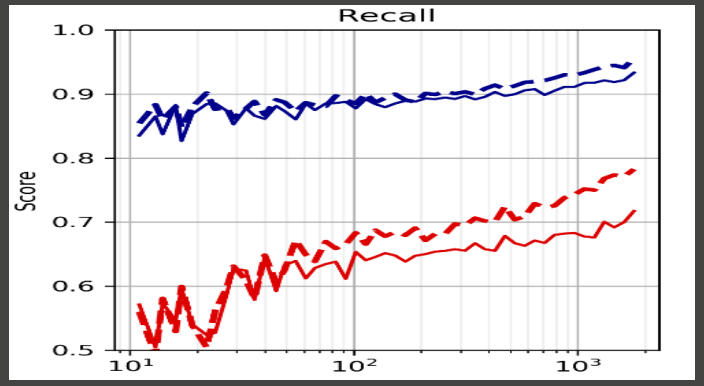




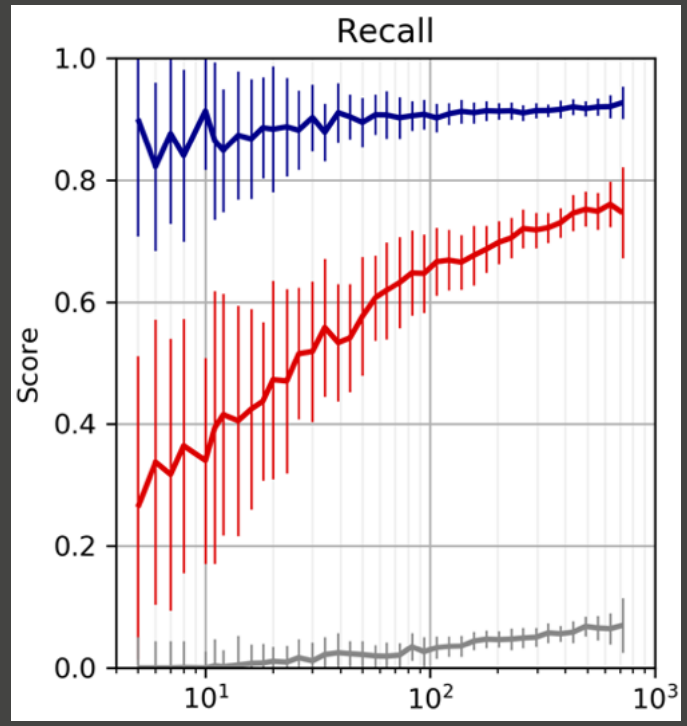


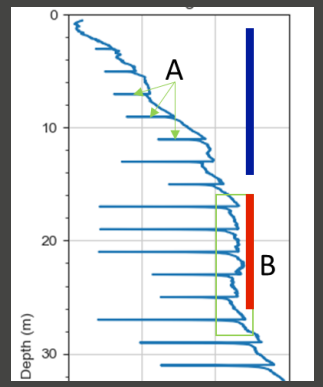


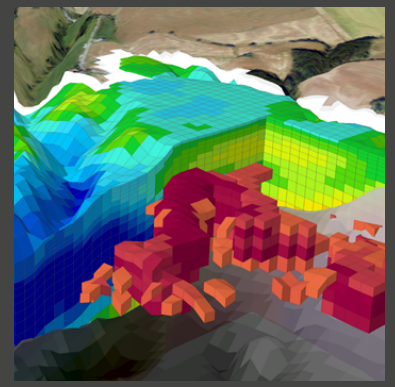
Recall of predictions



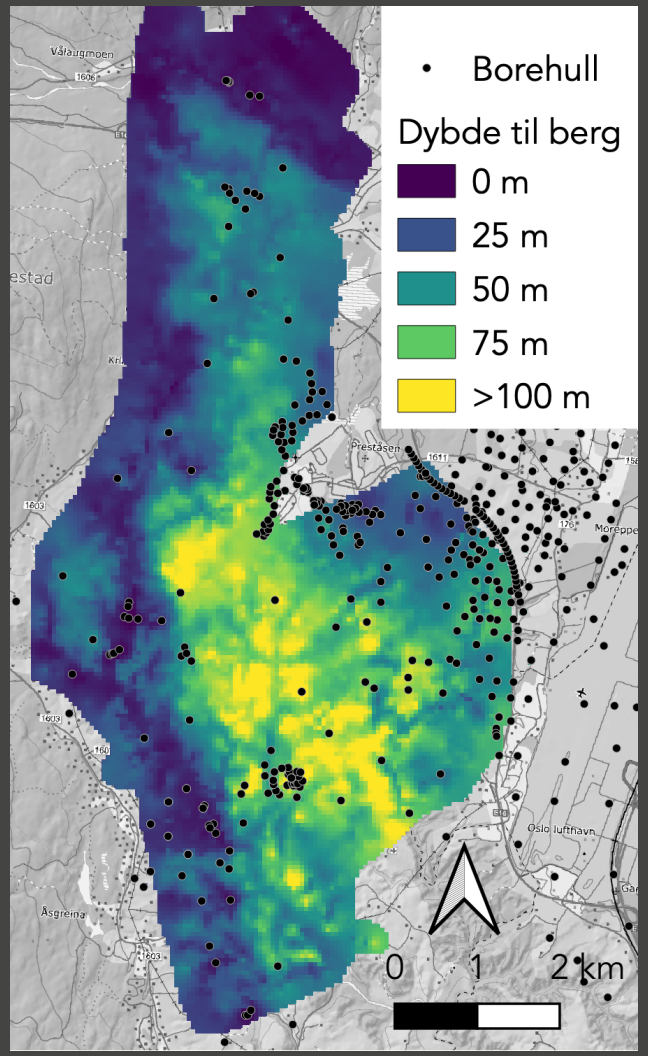
non-brittle
brittle
ambigious



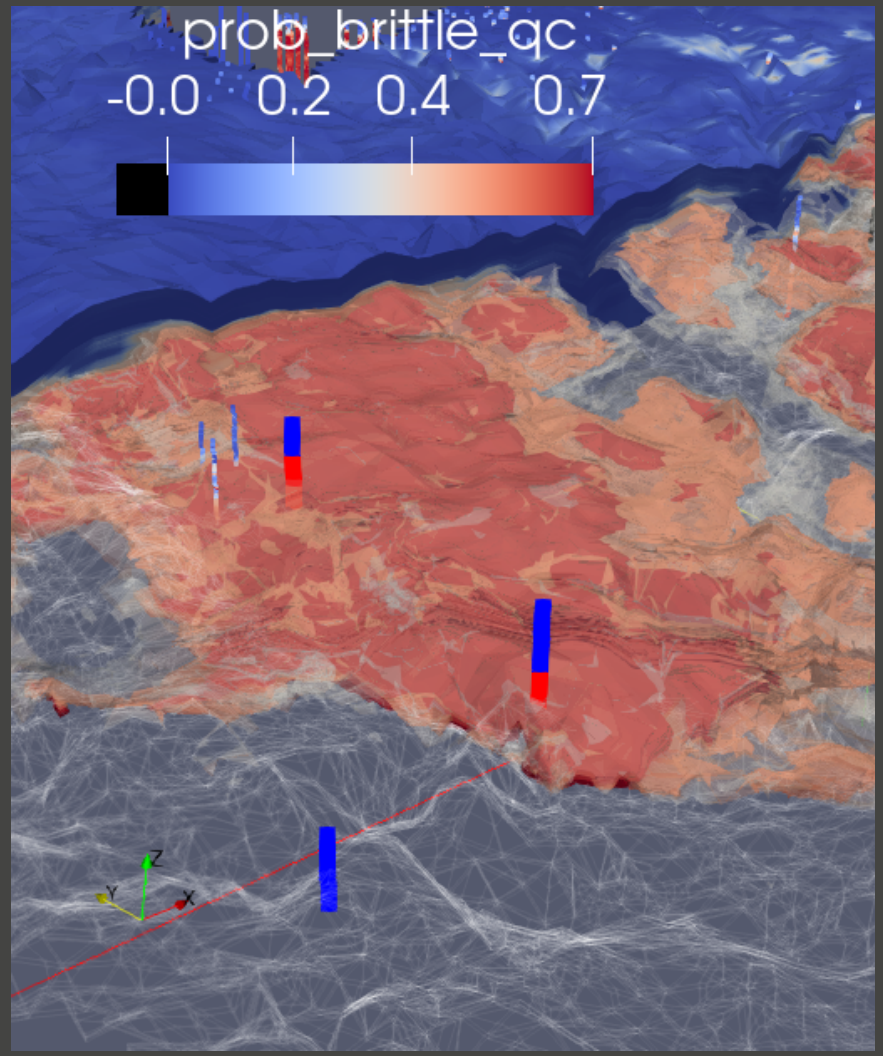




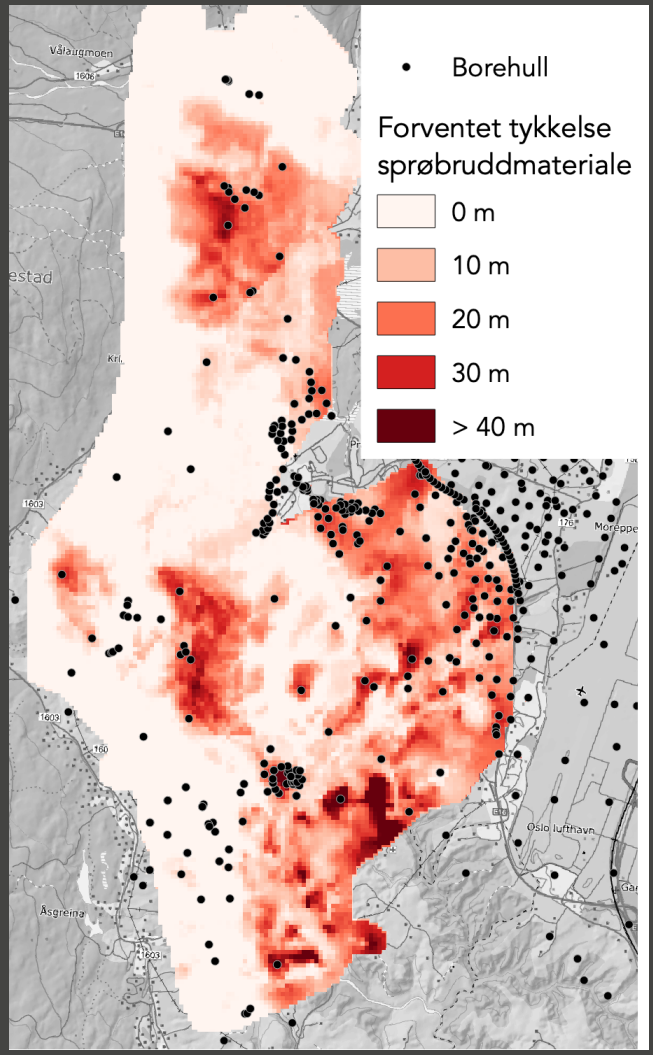
Brief project example



Dybde til berg

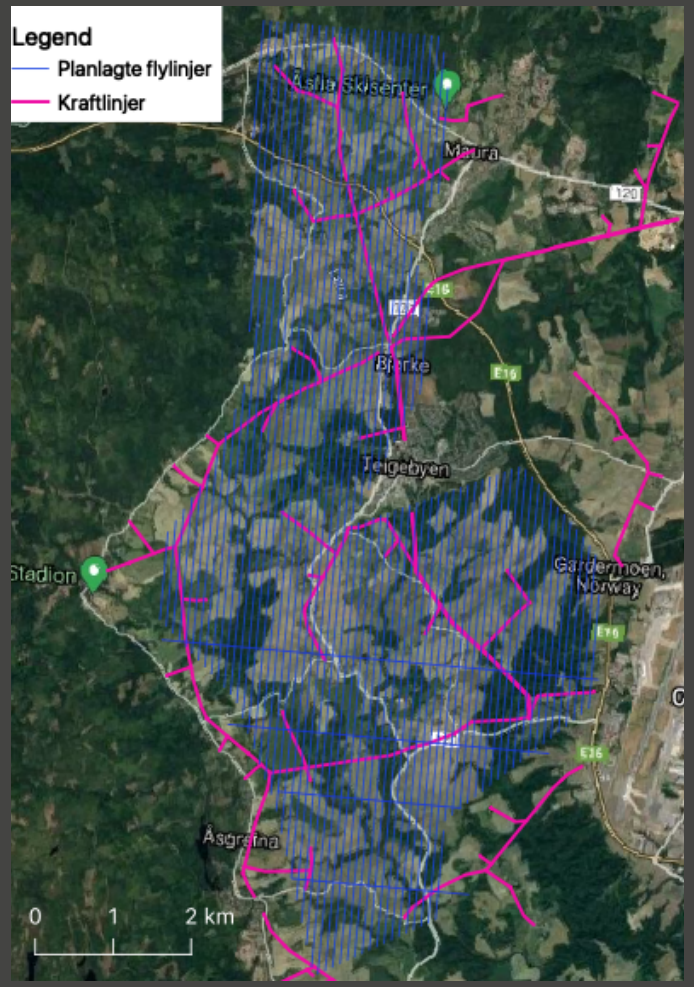


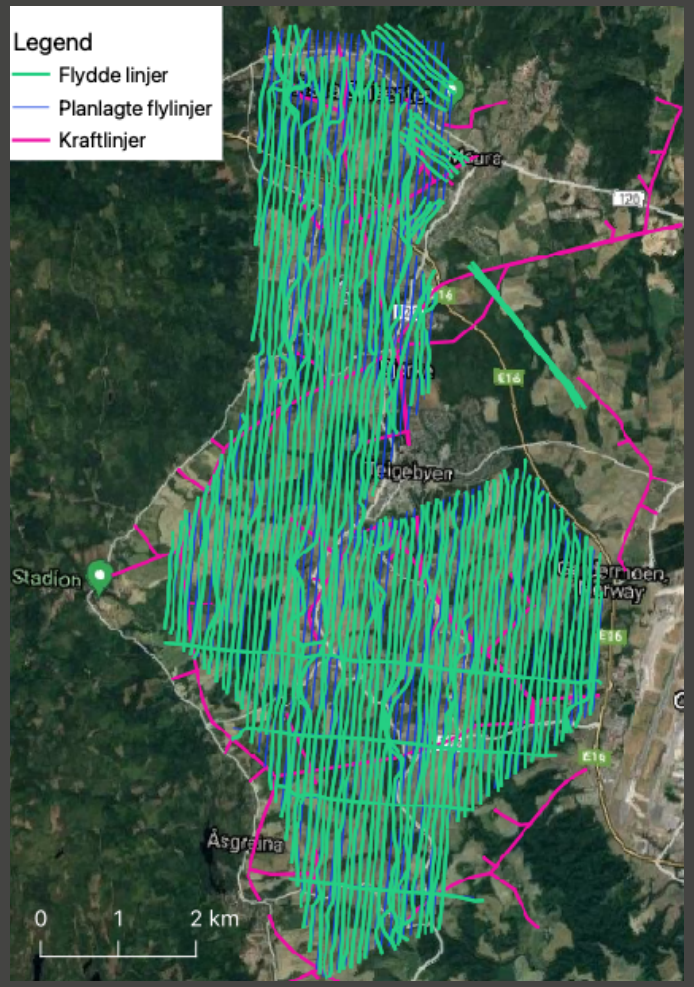
Sannsynlighet sprøbruddmateriale

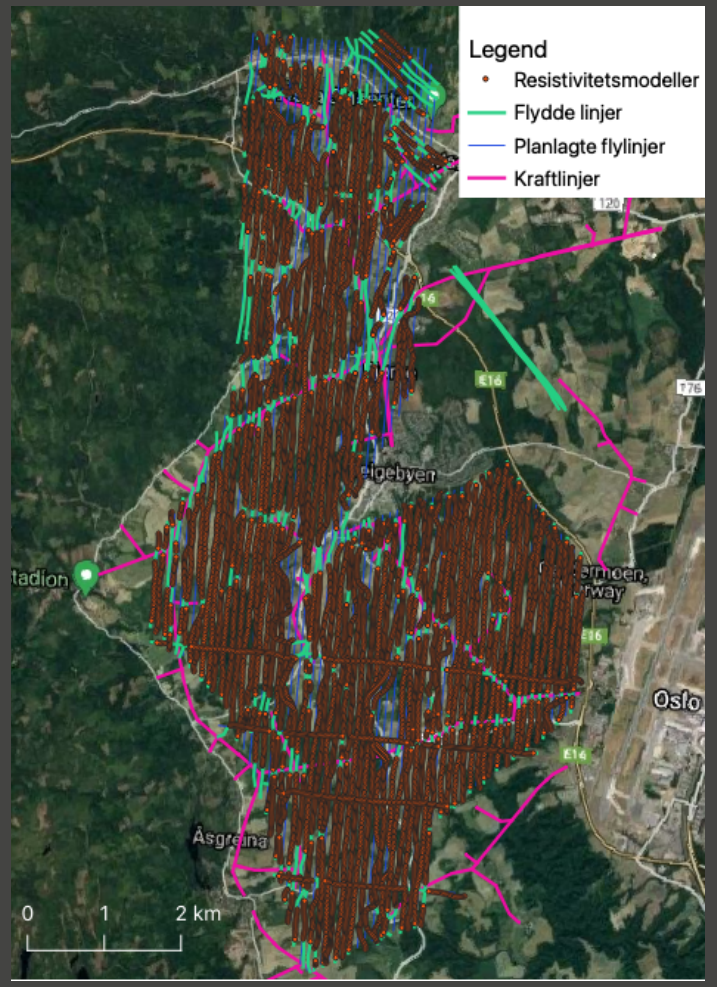


Forventet tykkelse sprøbruddmateriale

Geoscanning coverage example

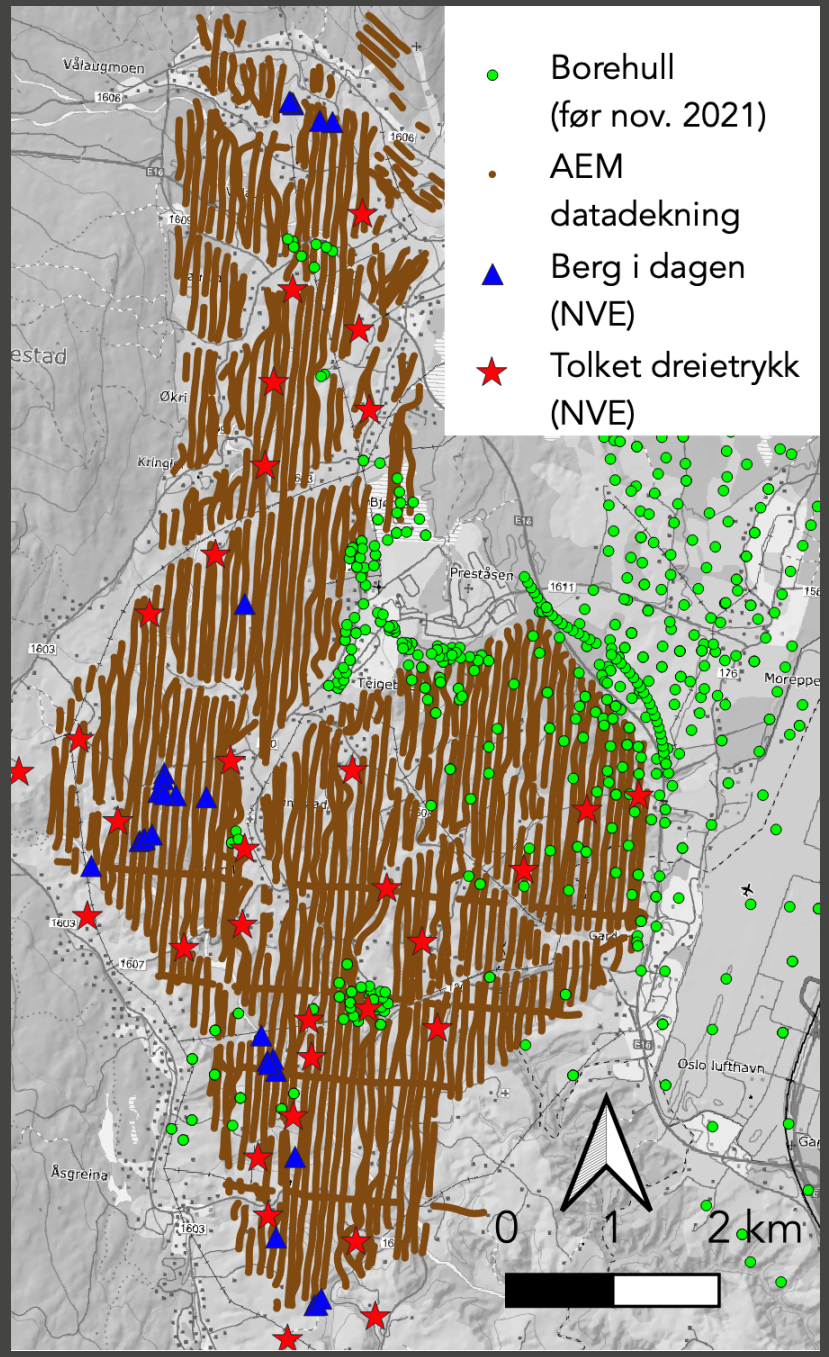






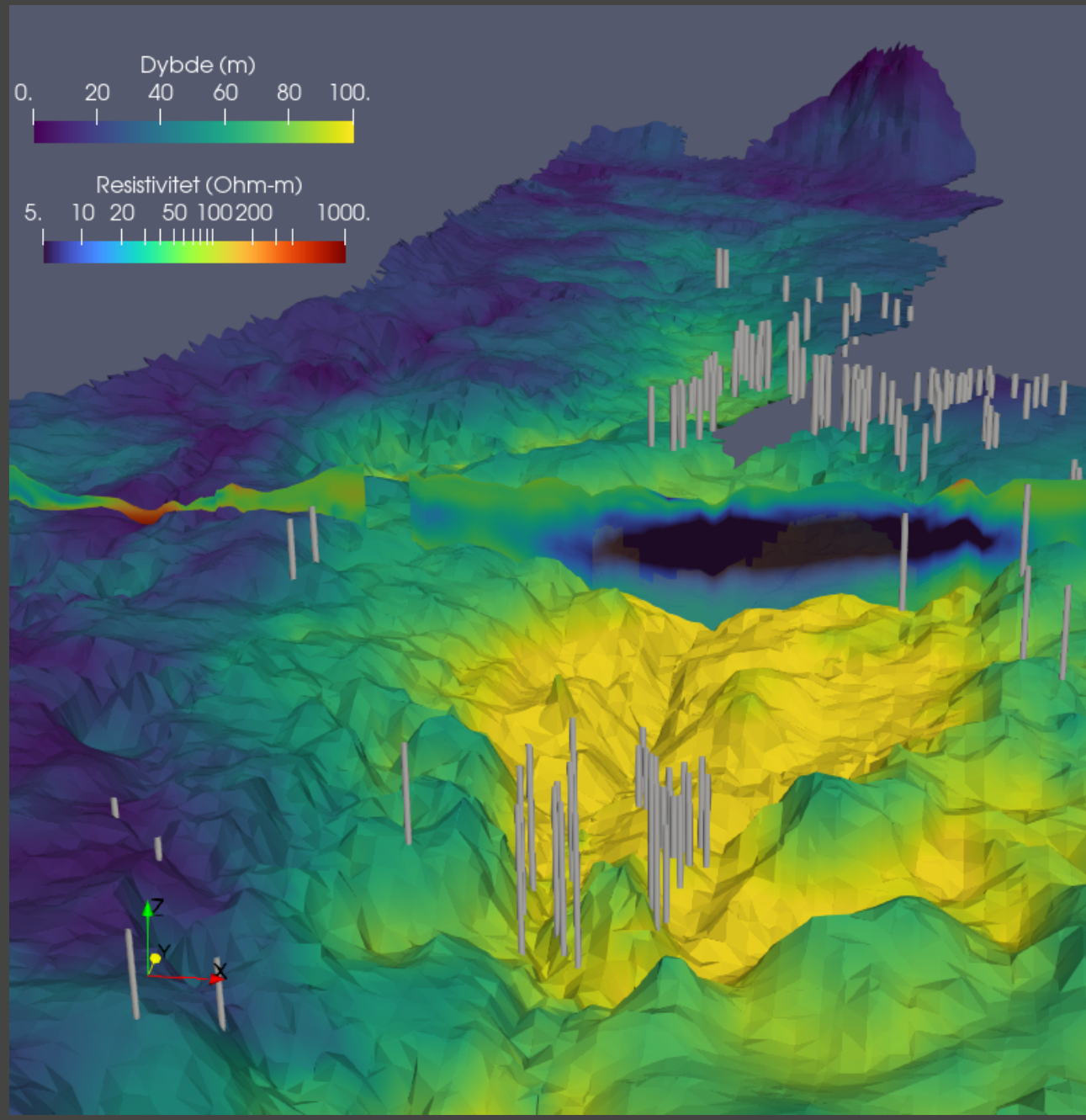
Background data

- *Boreholes from national database (268)*
- *Manually Interpreted boreholes (28)*
- *Mapped outcrops (23)*
- *Sediment maps*

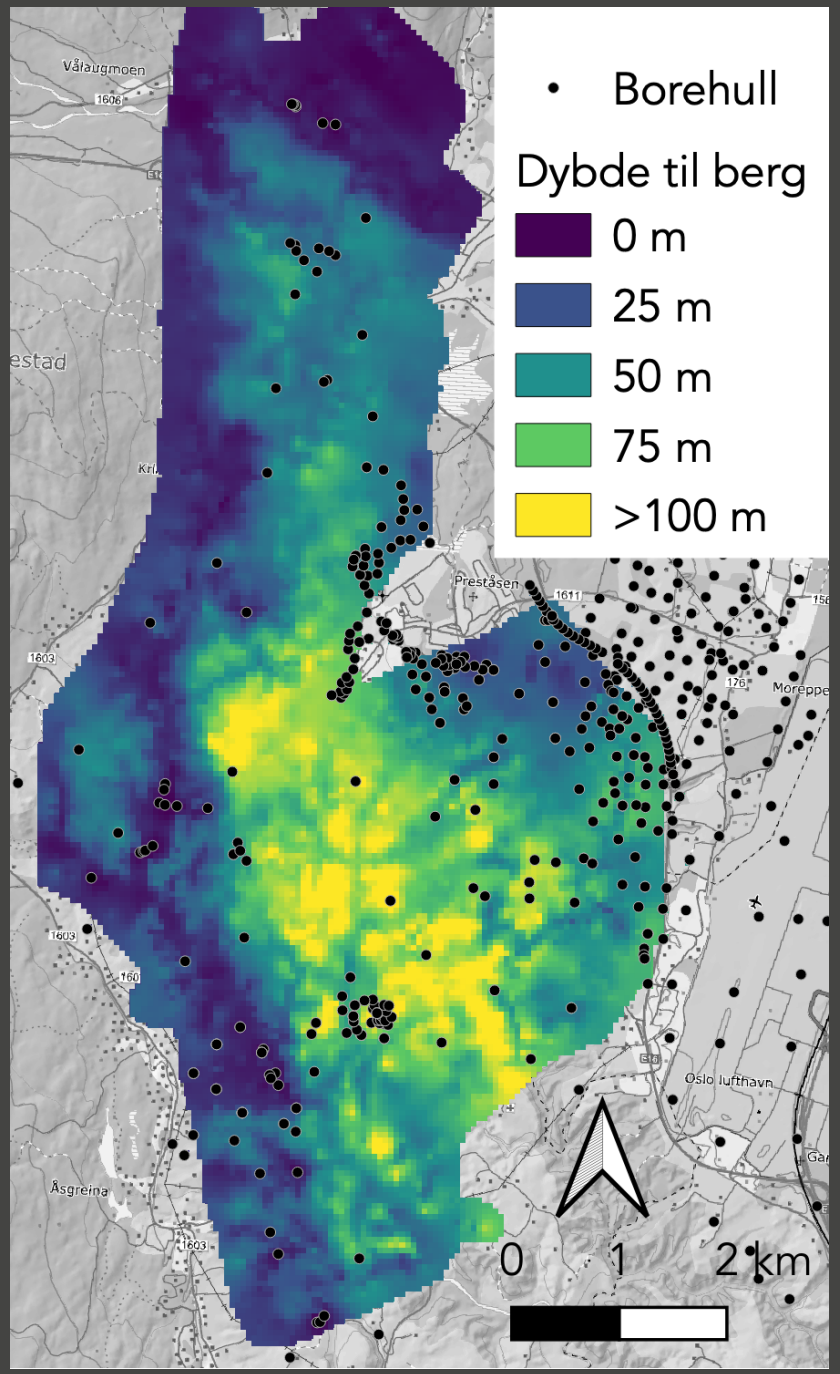


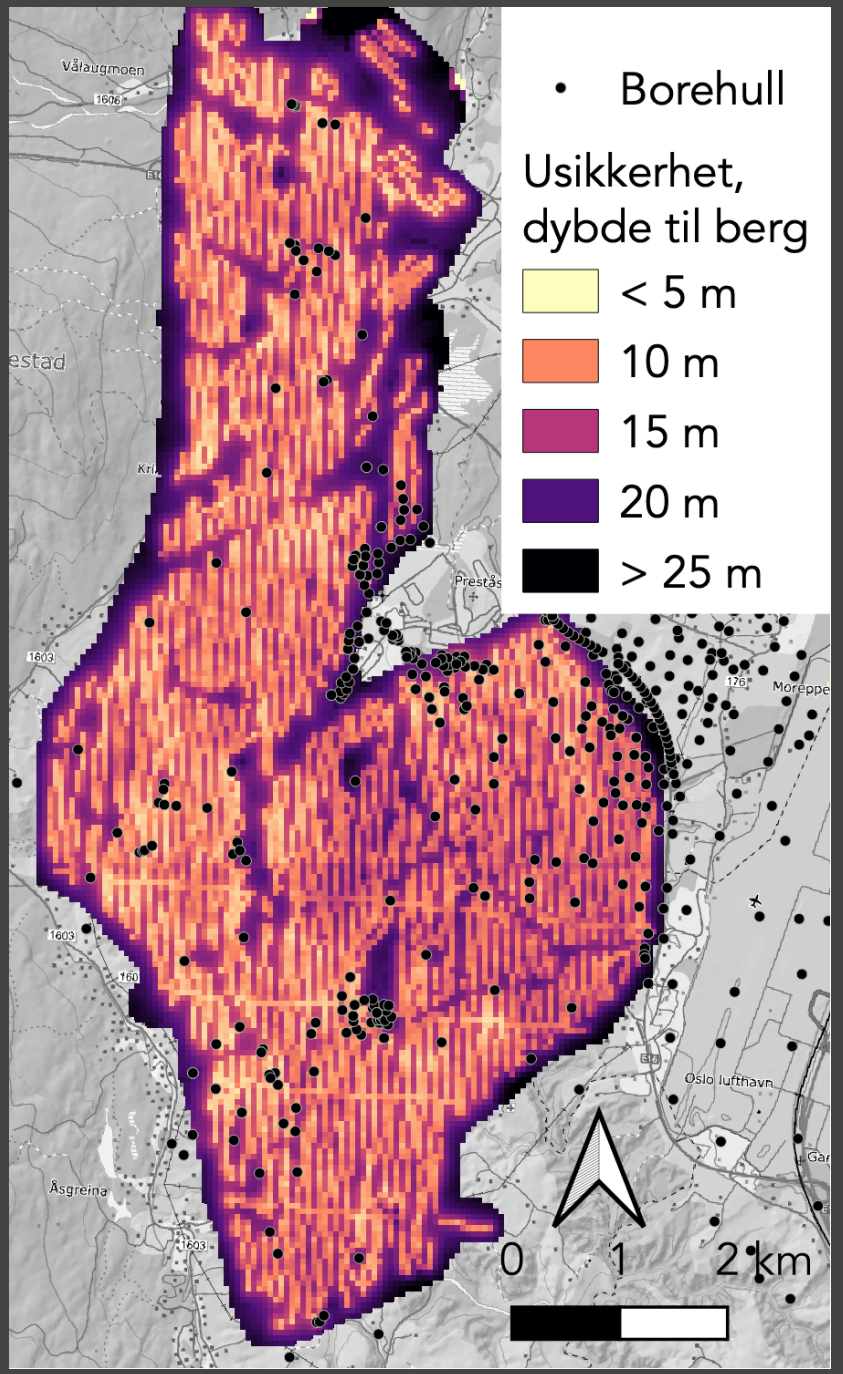
Bedrock model

- *Artificial Neural Network-based workflow*
- *Inputs:*
  - *Resistivity model*
  - *Boreholes*
  - *Outcrops*
  - *Manual training points*
- *Triangulated bedrock model*

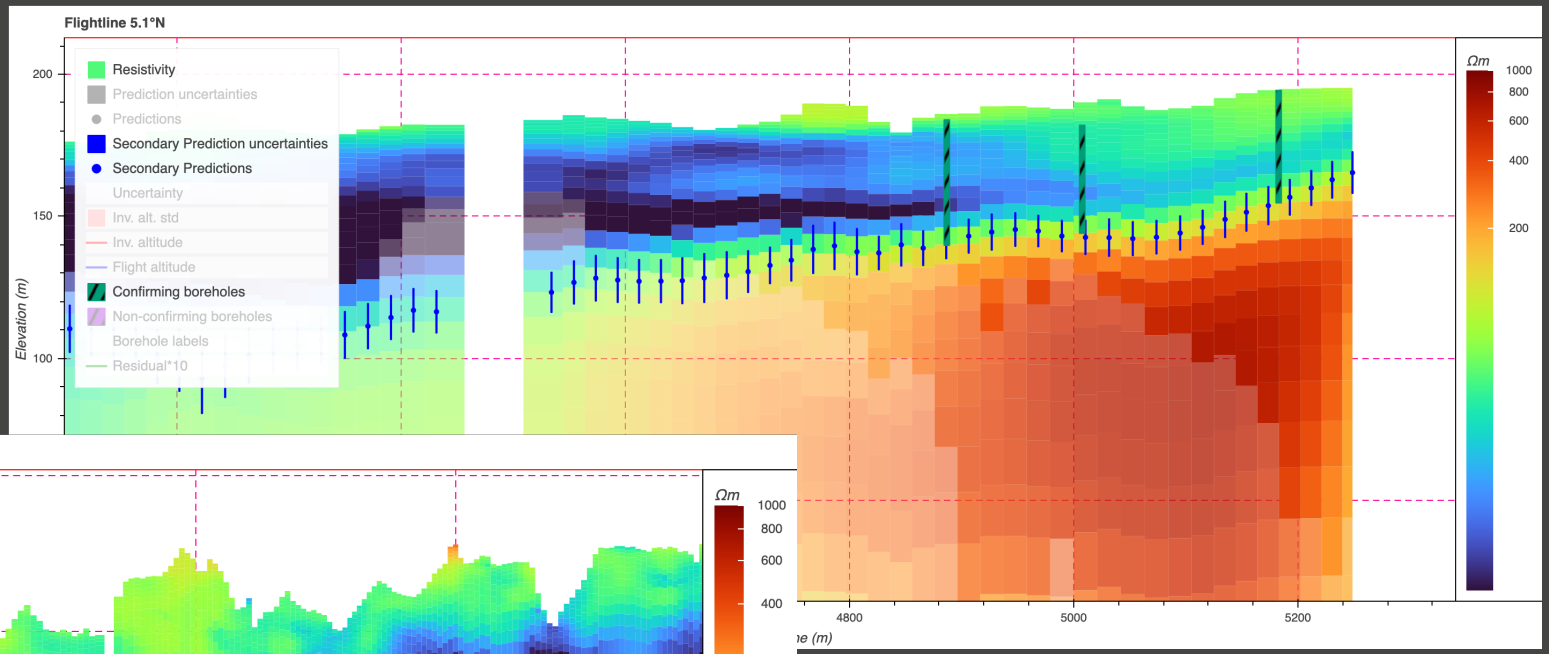


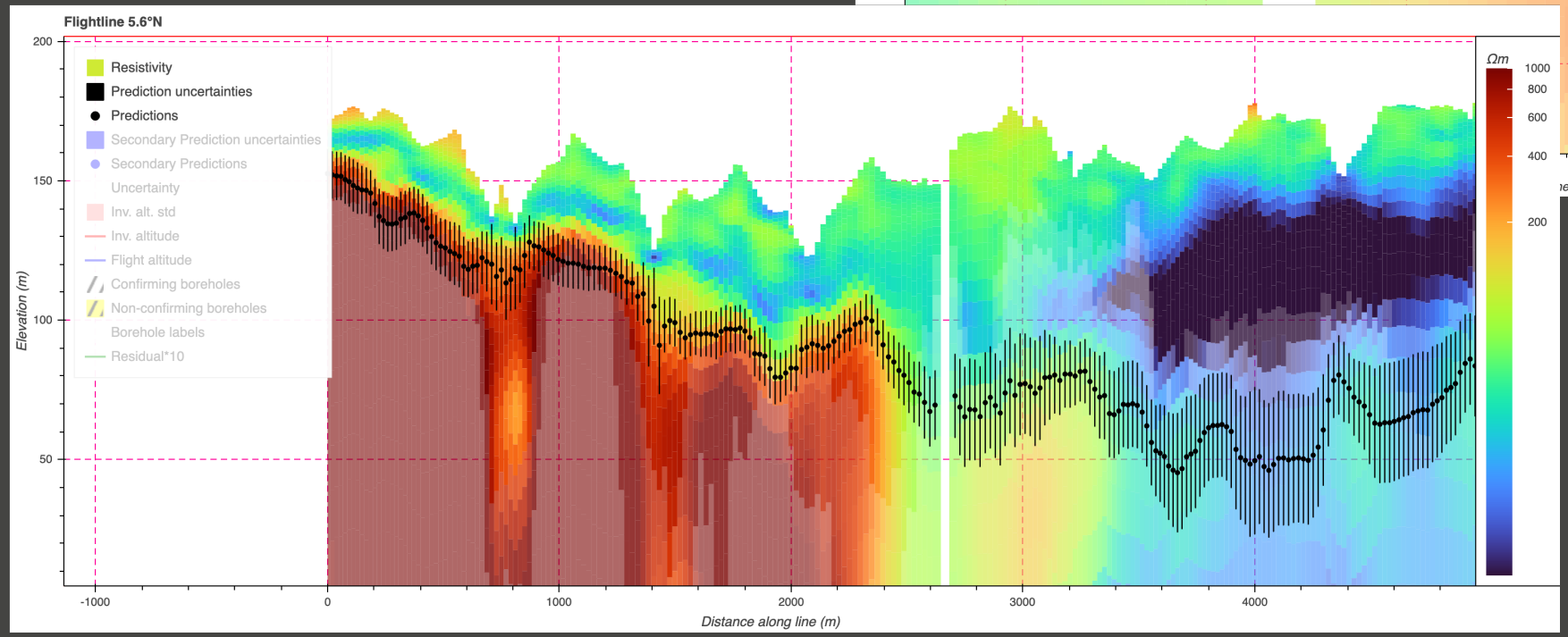
Bedrock model: Depth and uncertainty



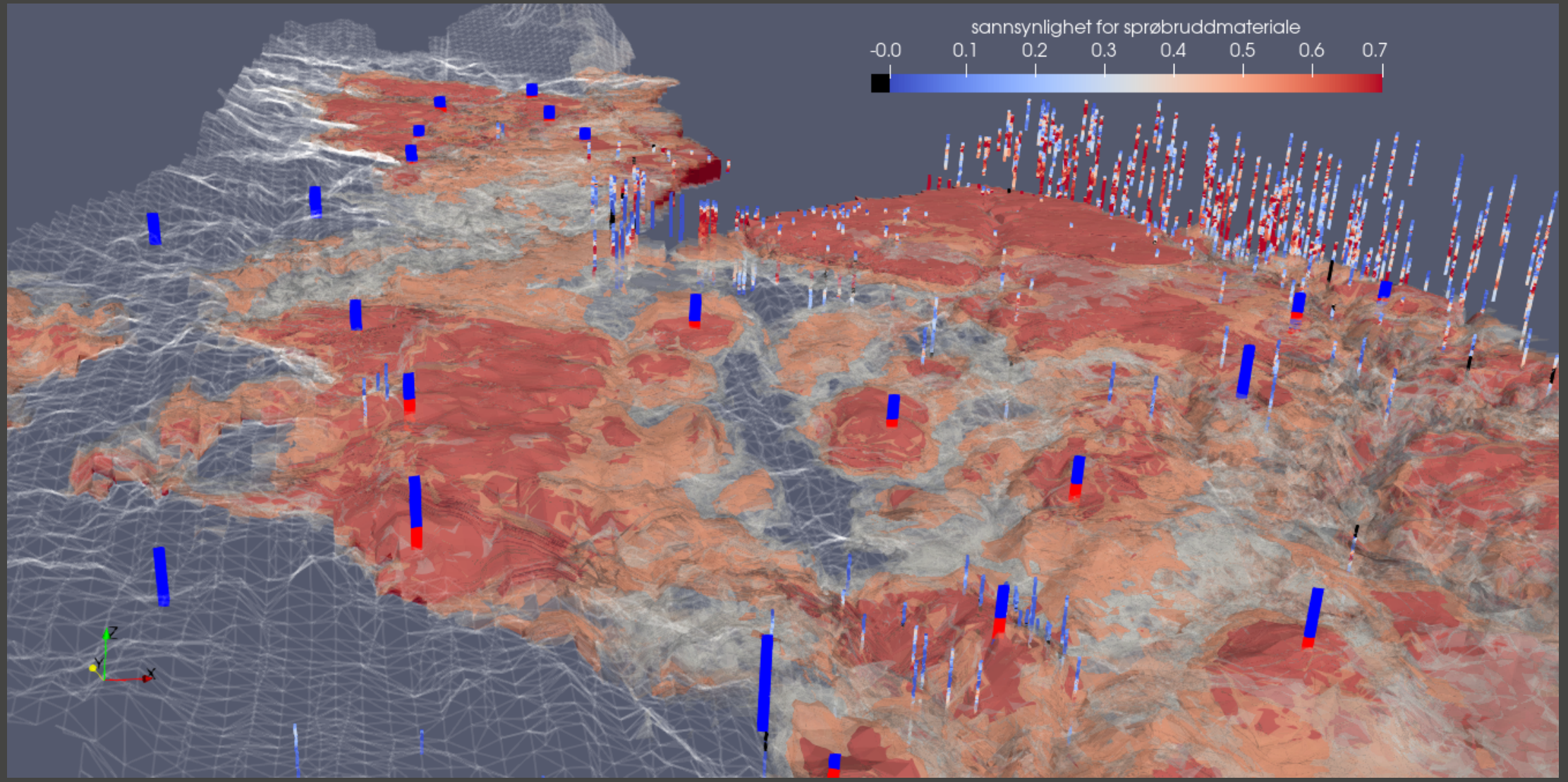


Example sections resistivity & bedrock



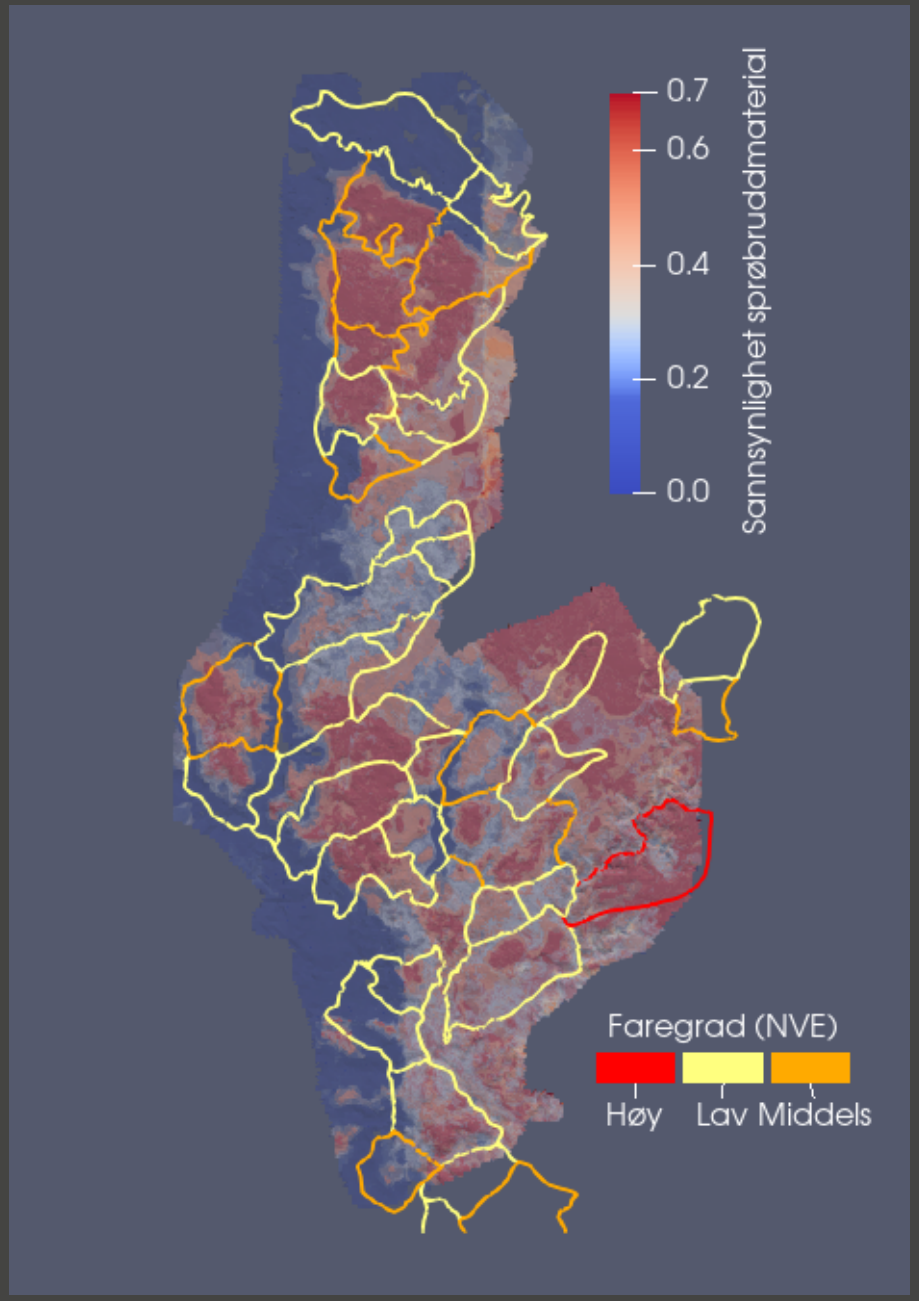


Brittle clay probability volumes



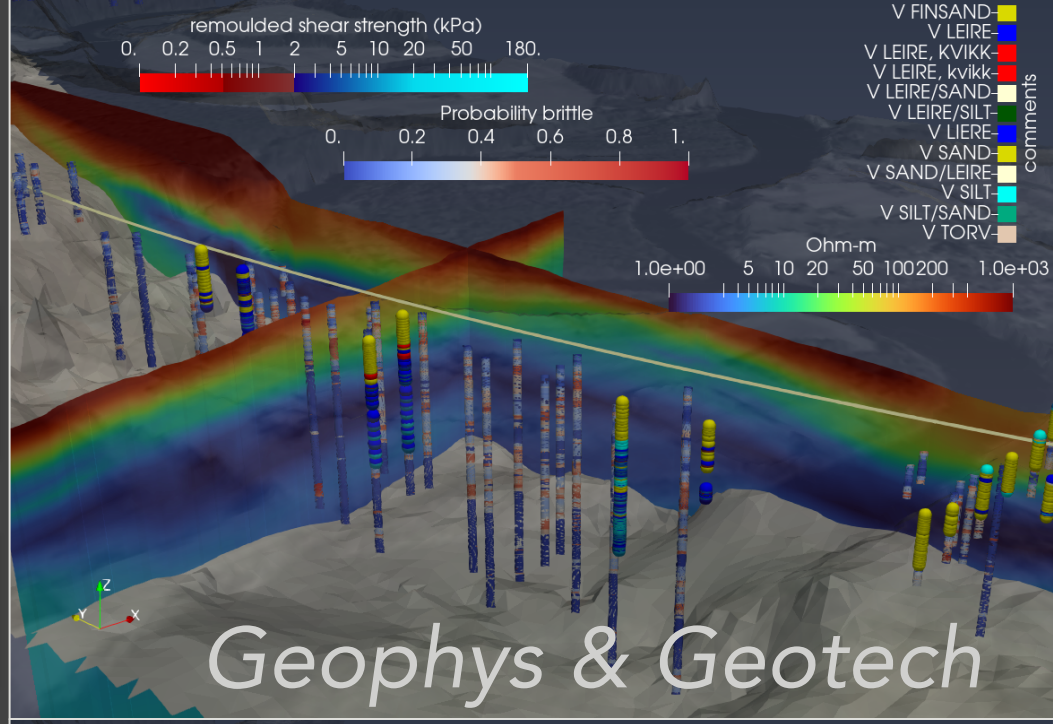
Limitations (?)

- *Petrophysics need to be robust*
- *Training data (soundings & samples) needs to be sufficient*
- *Models need to be "clean" – not influenced by data issues or infrastructure*

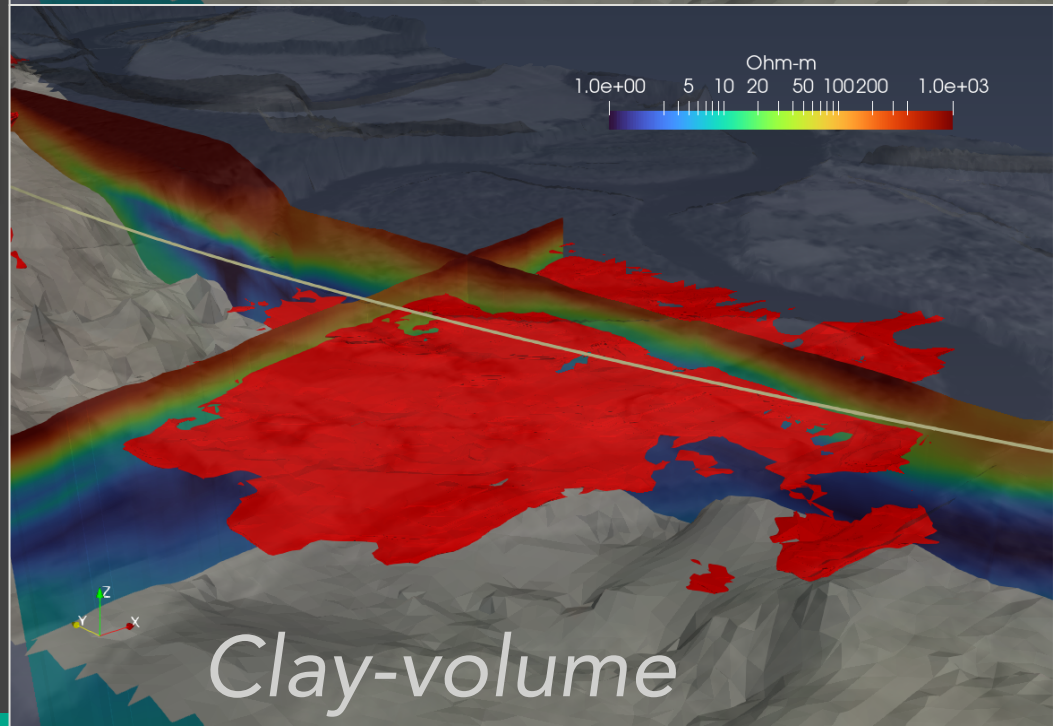


Summary

- ML can combine rather than compare
- … and derive probabilities
- Applicable in a complex real world
- Robust with limits



Geophys & Geotech



Clay-volume

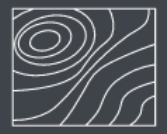
Thank you!



Geophysical data

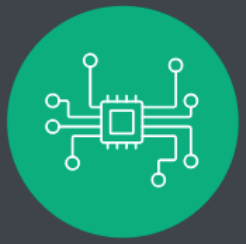


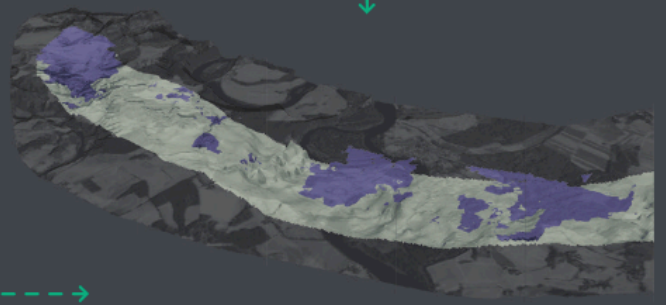
Geotechnical data



Geological data

Machine Learning





Model



Project owner



Project engineer

Andi A Pfaffhuber
aap@emrld.no
andipfaffhuber

The value & accuracy of combining resistivity with drillings

