

Joining Forces 2016, Stavanger 2nd and 3rd of February 2016

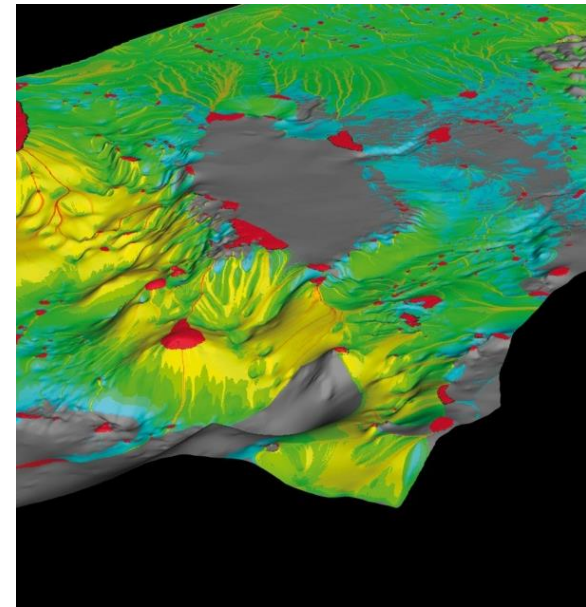
Exploration research at SINTEF Petroleum

Ane Lothe

Research Manager, Basin Modelling Group

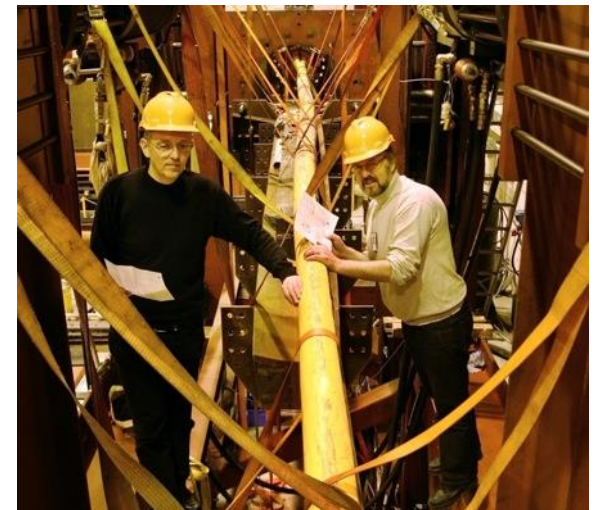
Overview

- Short about SINTEF
- Basin Modelling - key software and ongoing projects
- Geophysical methods- key software and ongoing projects
- Shallow Drilling Database



SINTEF is the largest independent research organisation in Scandinavia

- Leading expertise in the natural sciences and technology, environment, health and social science
- 2100 employees from 70 countries
- Annual sales of NOK 3 billion (EUR 400 mill) – customers in more than 60 countries
- A non-commercial research foundation with subsidiaries



A multidisciplinary research organisation with international top level expertise in specific fields

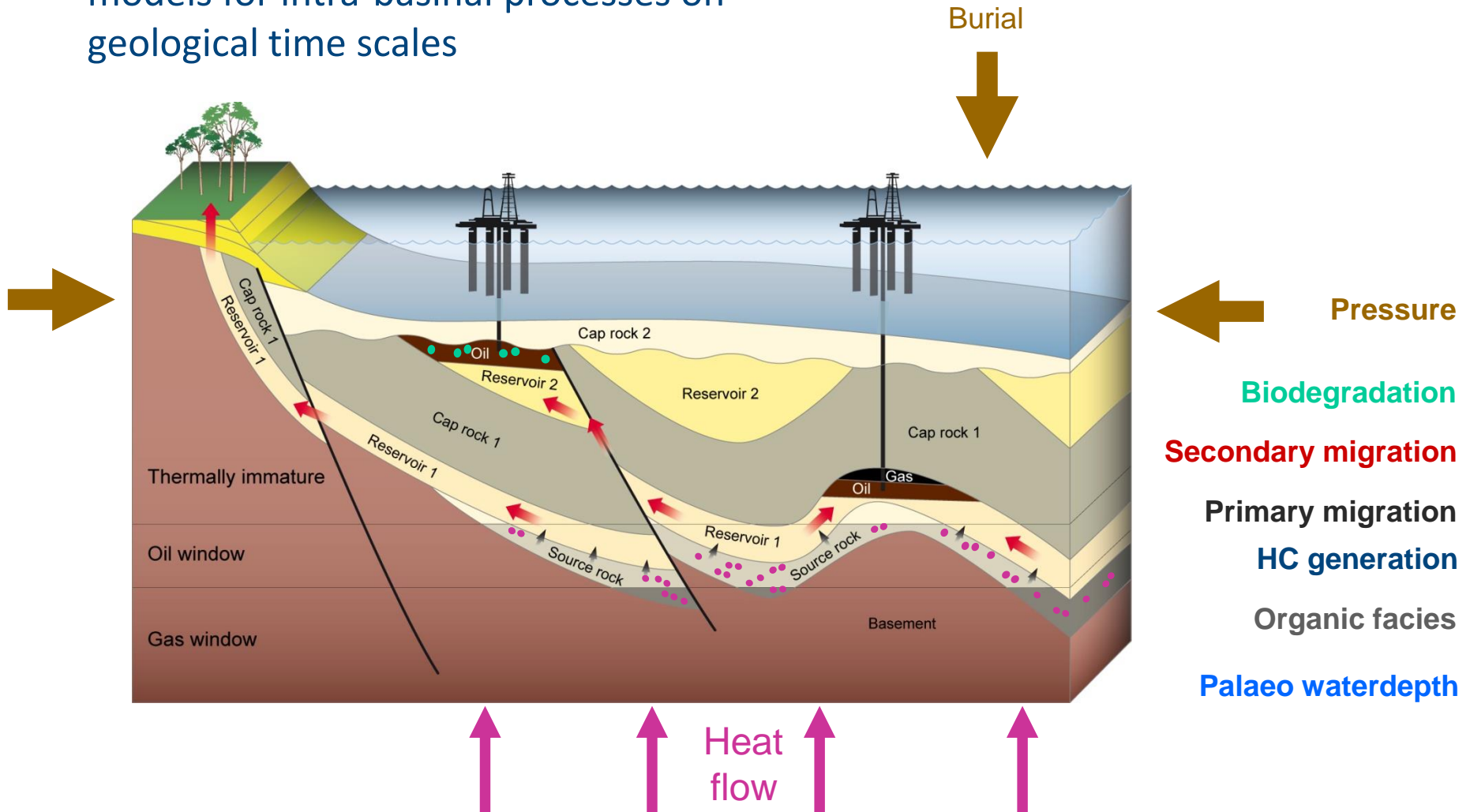
Departments:

- ❖ Drilling and Well
- ❖ Formation Physics
- ❖ Exploration and Reservoir Technology
- ❖ Basin Modelling, Reservoir and Geophysics Group
- ❖ Wellstream Technology

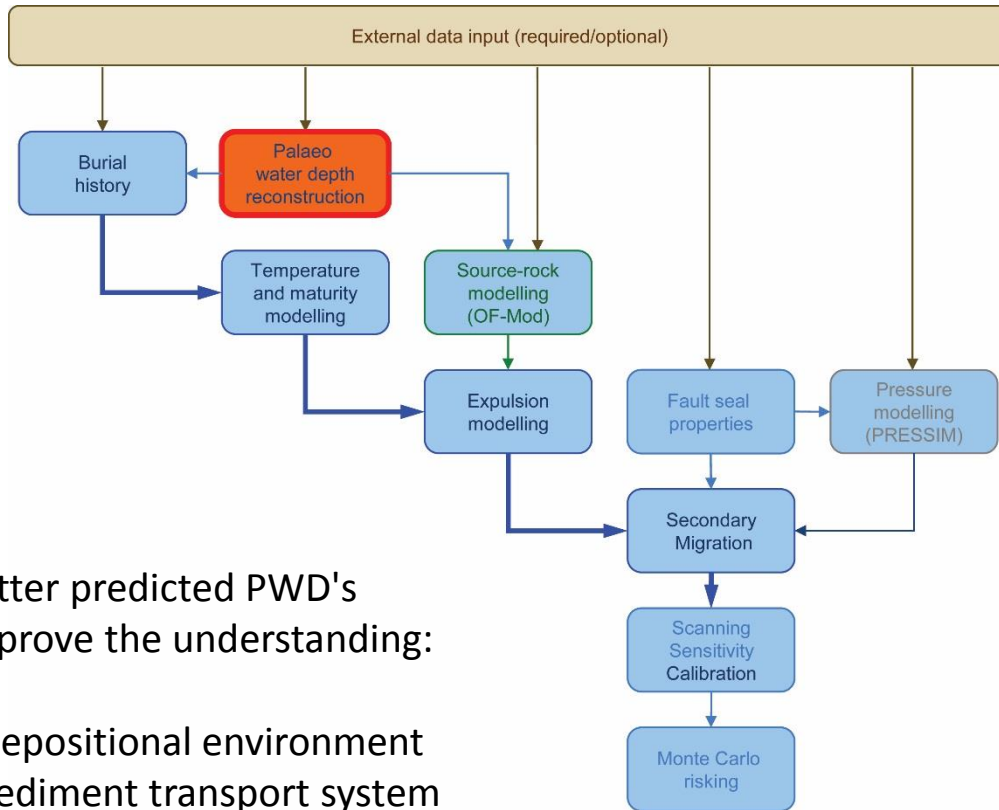


Basin / petroleum systems modelling

Development and application of mathematical models for intra-basinal processes on geological time scales

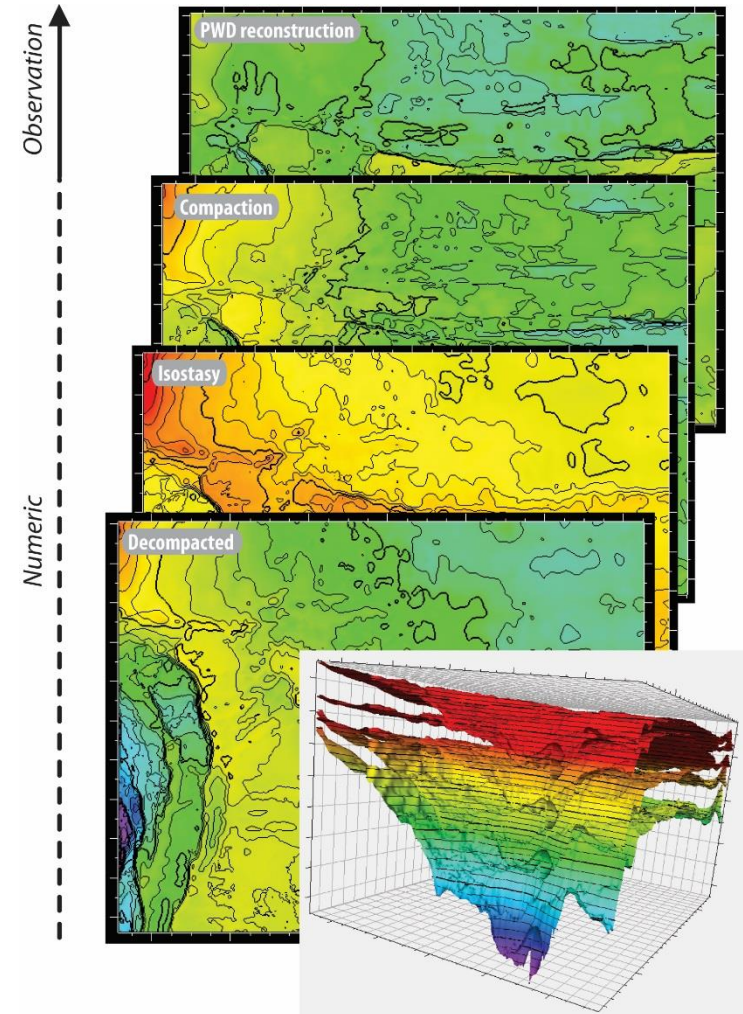


Why paleo water depth modelling is important

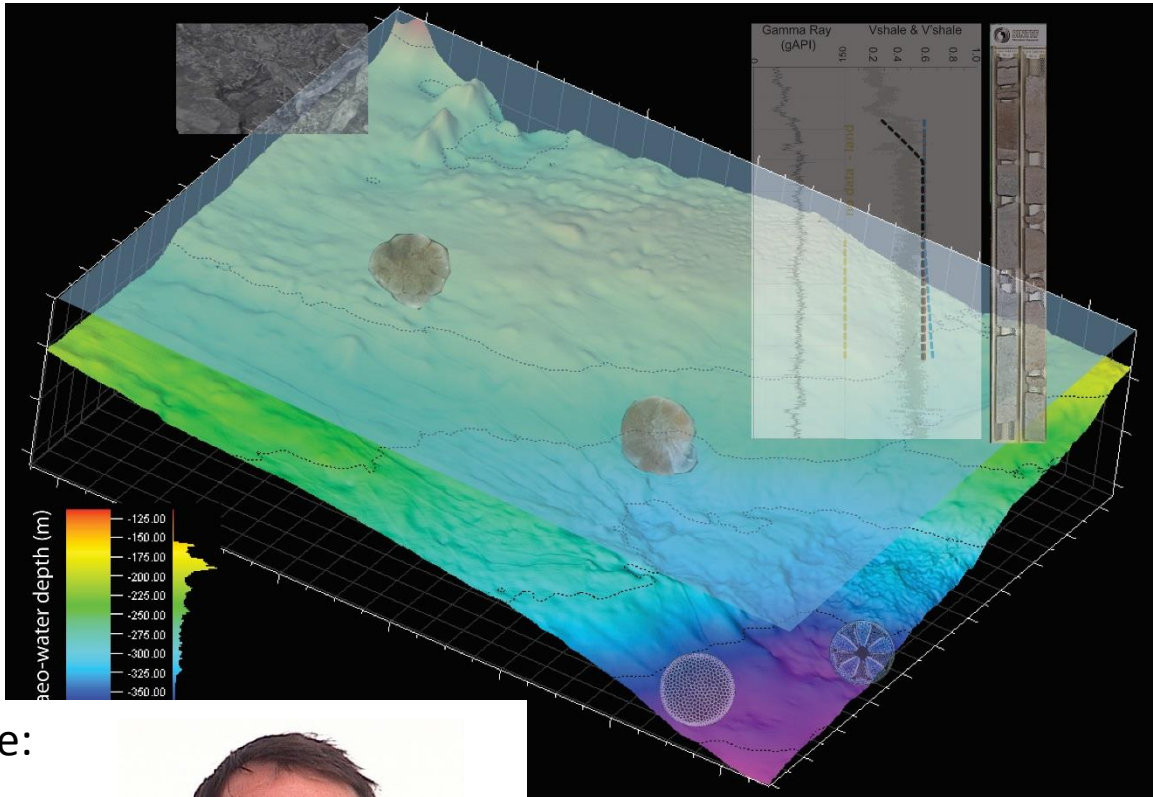


Better predicted PWD's improve the understanding:

- Depositional environment
- Sediment transport system
- Distribution of source rocks
- Migration of hydrocarbons



A new tool to reconstruct and calibrate palaeo-water depth (PWD)



Main responsible:

Benjamin Emmel



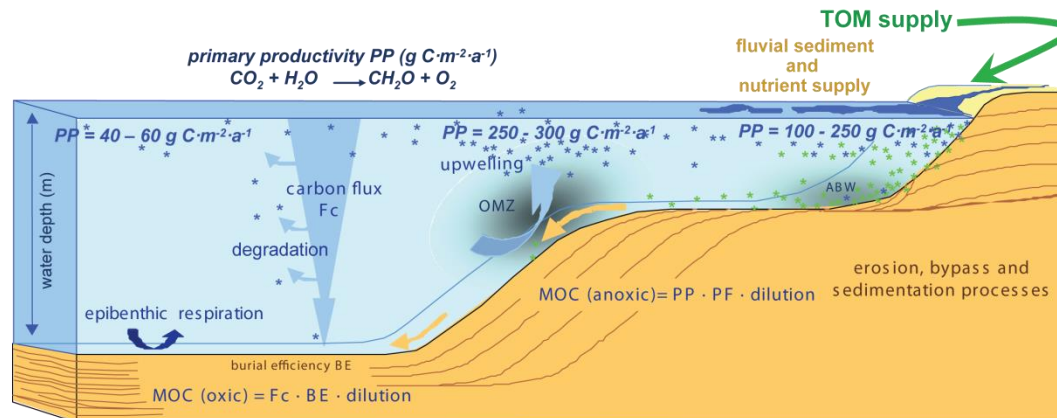
Software development project
Duration: 2015 –2018

OF-Mod

OF-Mod = Organic Facies Model: calculates the original distribution of organic matter in a source rock. This can be used as input in basin modelling studies.

Importance: the quality of a source rock determines how much and what type of oil or gas can be generated.

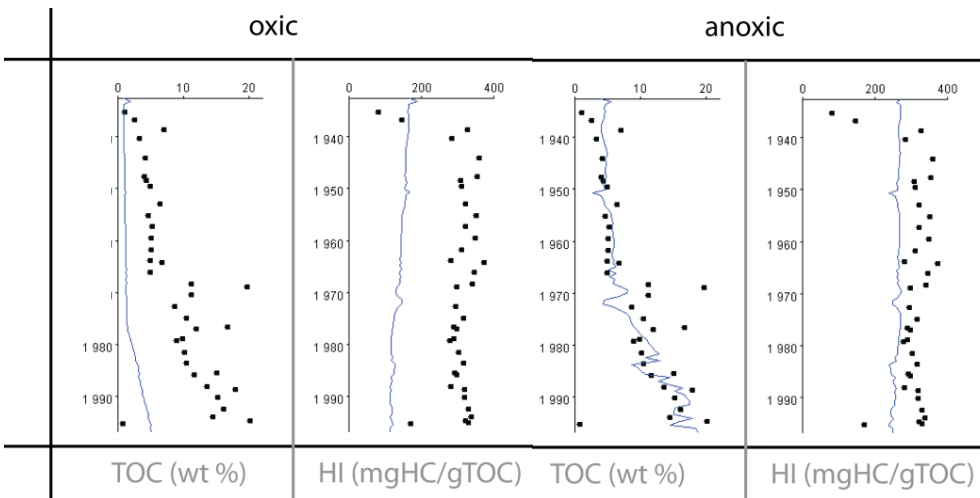
How: OF-Mod is a process-based model. This means that models the processes which caused a source rock to be deposited. This helps in frontier areas where there is very little data available.



Processes included in OF-Mod

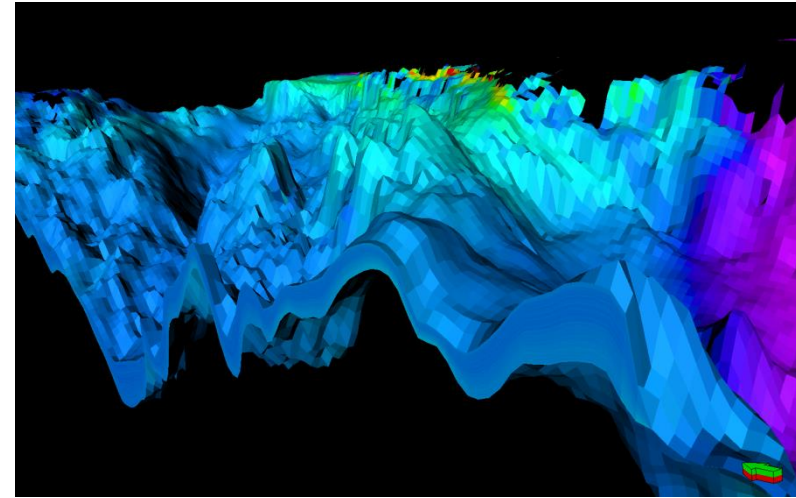
High resolution source rock modelling

- Vertical and lateral variation essential for petroleum system modelling
- Validated on well data

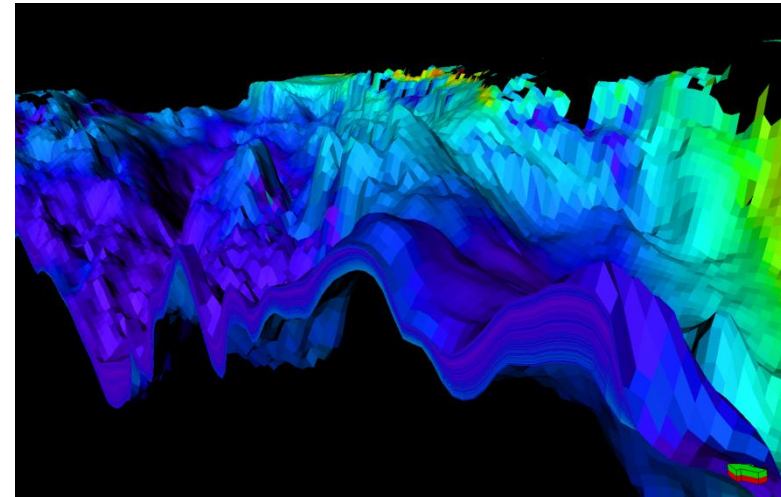


- Quick tool, therefore easy to test different scenarios quickly

Hydrogen Index



Total organic carbon



OF-Mod recent and current projects

2014 Modelling the Jurassic Hekkingen Formation, Barents Sea. Partner: **Migris**

2014 *Industrialization* of OF-Mod. Partners: **ConocoPhillips, ENI, Petrobras**

2014 2-day workshop MSc students at **Newcastle University**

2014-2015 Modelling source rocks offshore Brazil. Partner: **SINTEF do Brasil**

2014-2016 Modelling three Cretaceous source rocks in the Colombian Eastern Cordillera. Partners: **Ecopetrol, Newcastle University**

2015 Modelling two formations in the Barents Sea. Partner: **ENI**

2015 three MSc students finished their MSc research using OF-Mod.

Partner: **Newcastle University**

Main responsible:

Gerben de Jager



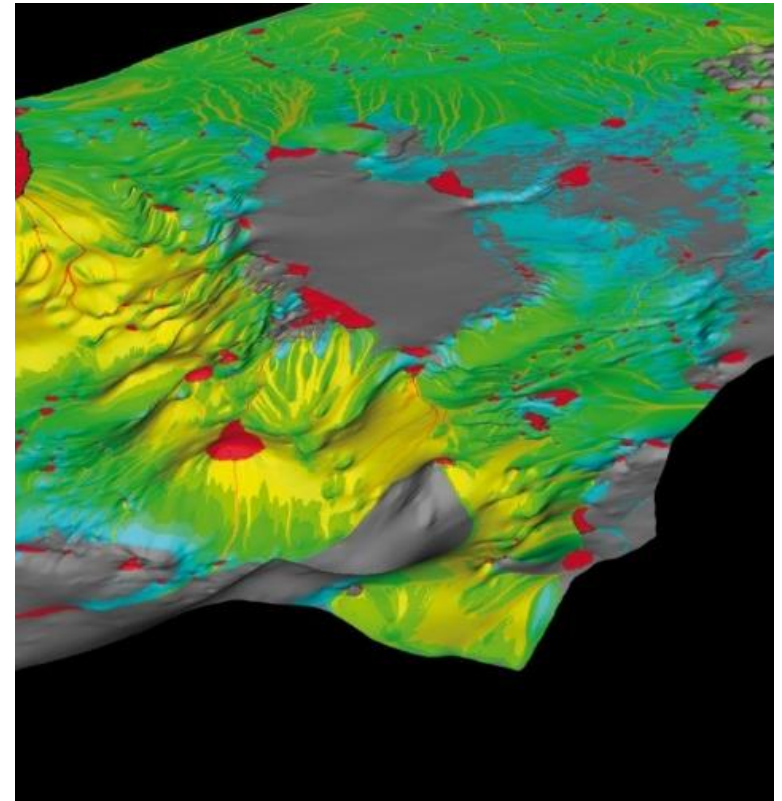
Earlier OF-Mod case study locations

Impact of Cenozoic structural development and glacial erosion on gas expansion, hydraulic fracturing and leakage in the Western Barents Sea

- The structural development in the Western Barents Sea during the Cenozoic (66-0 Ma) is complex with multiple erosion events and glaciations
- Study effects on top seal and possible hydrocarbon leakage
- PhD student: Krzysztof Zieba
- 2012-2015 research project for ENI

Main responsible:

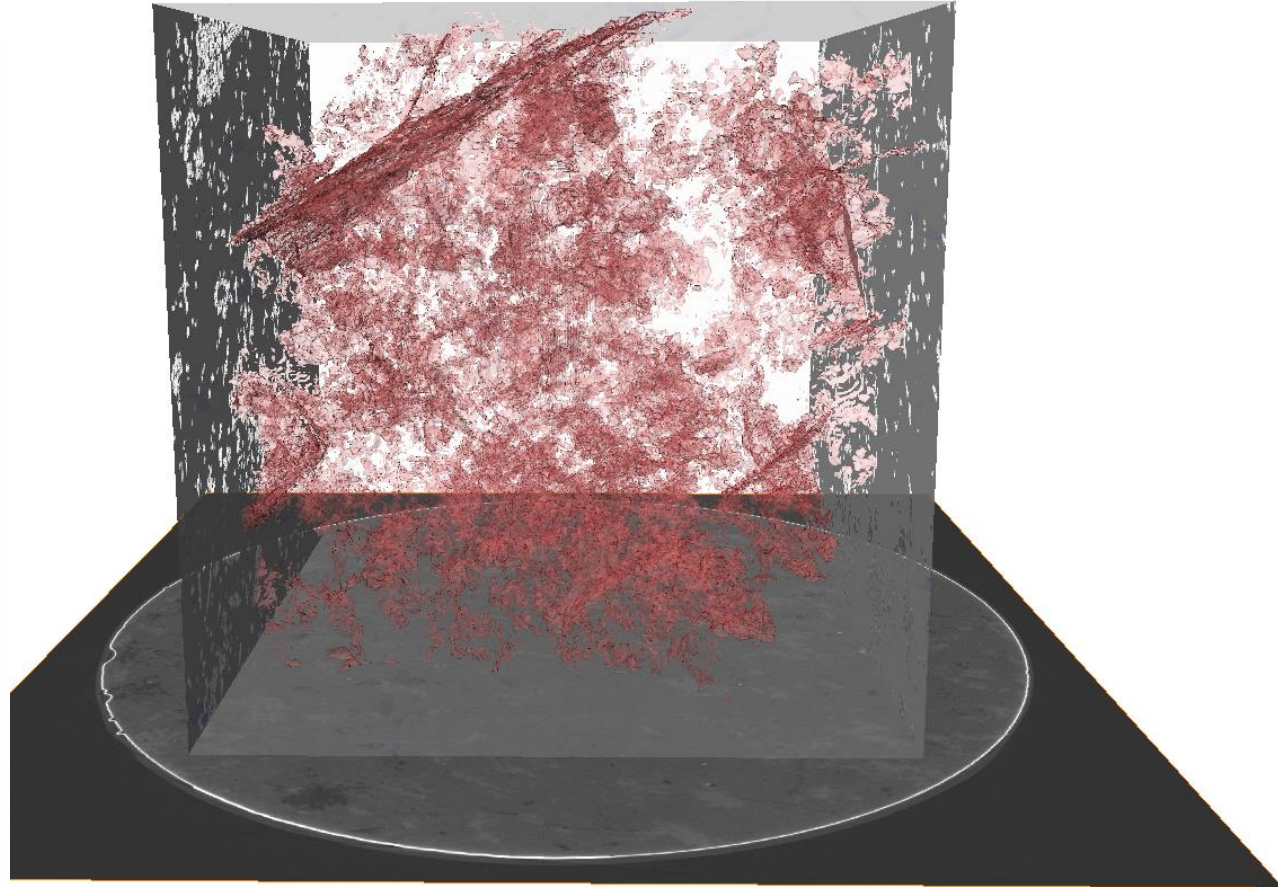
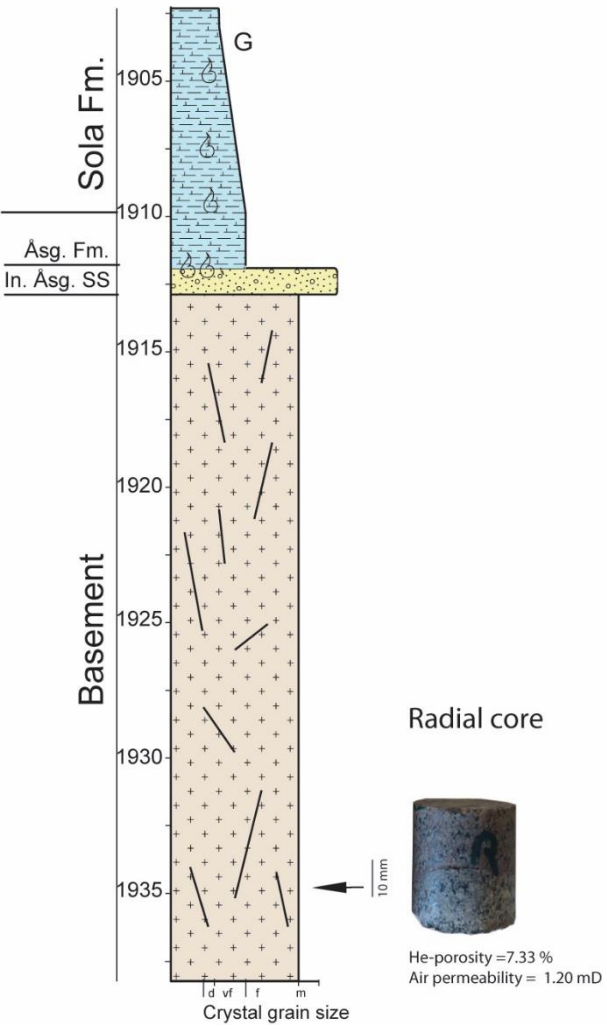
Arnt Grøver



BASE – fluid flow along weathered and fractured basement

Porosity – conventional and micro CT image analysis

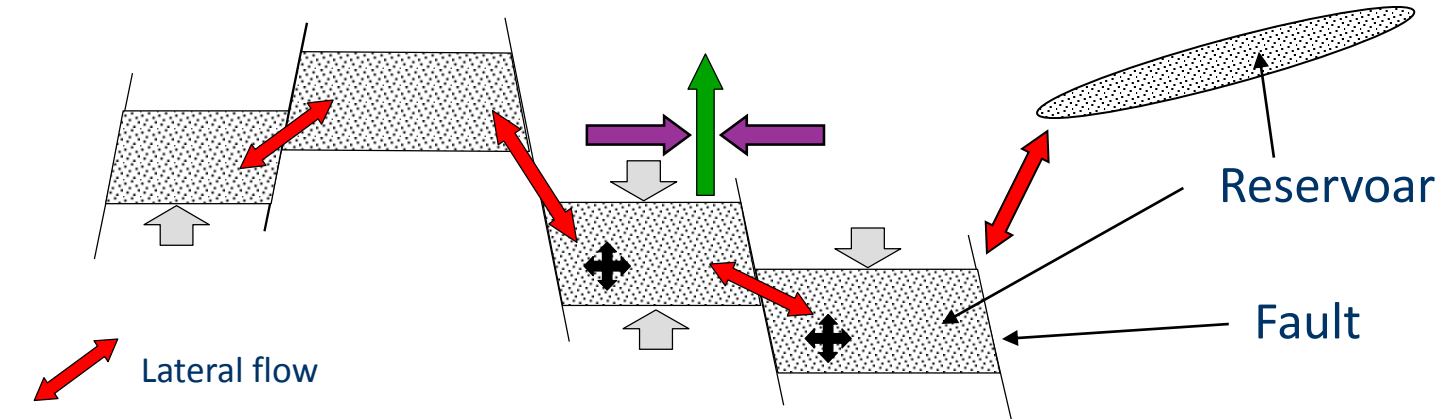
2013-2017



He-porosity (conventional): 7.33 %
Micro CT derived porosity: 3.15 - 6.1 %



pressim

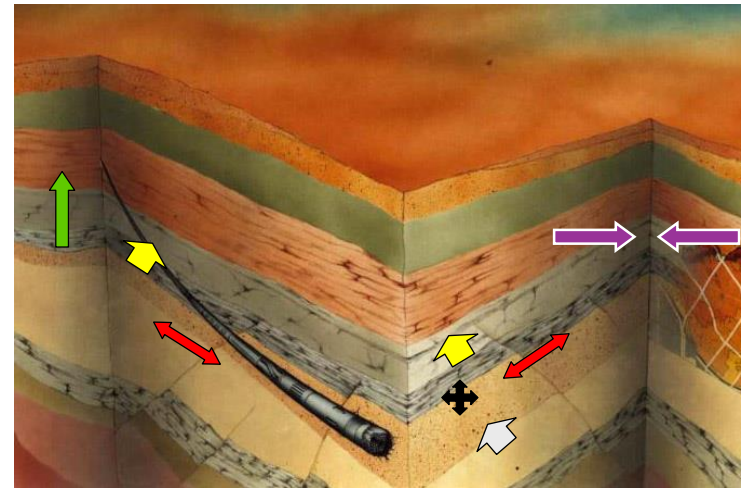


↑ Shale compaction

⊕ Quartz cementation

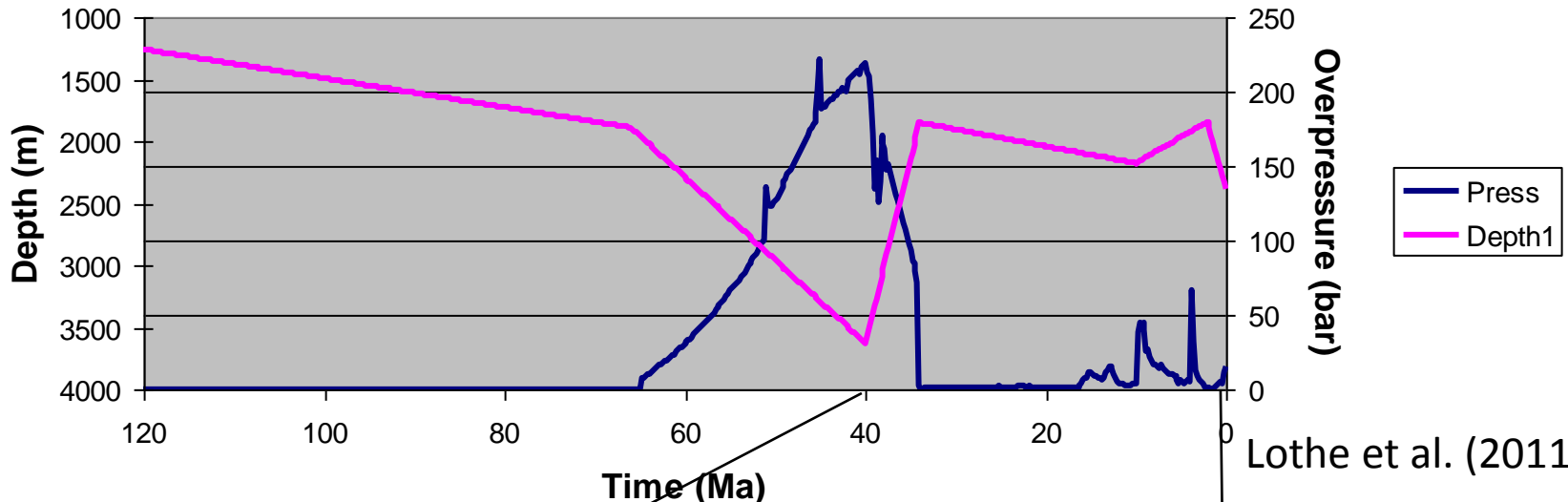
↑ Hydraulic leakage

→ Vertical and min. horizontal stress



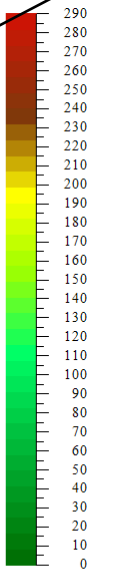
Pressim models all processes for pressure generation and dissipation –
unique features related to modelling of 3D fluid flow

Cell 65 Stø Formation



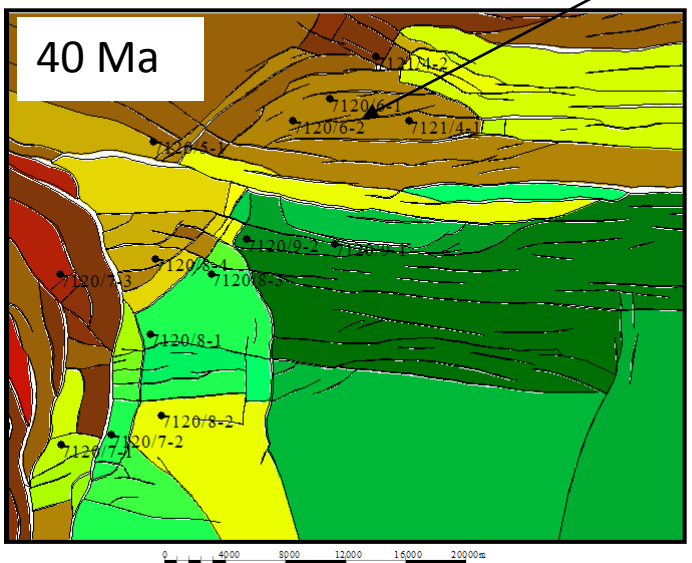
Lothe et al. (2011)

Time (Ma)

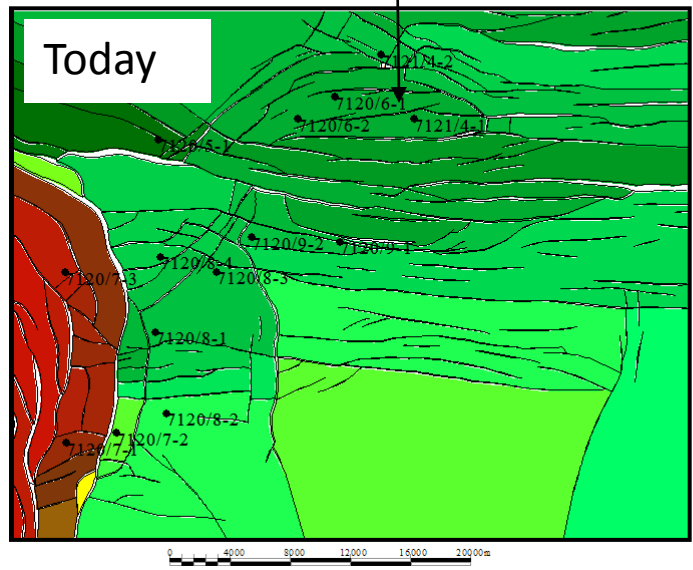


Overpr (bar)

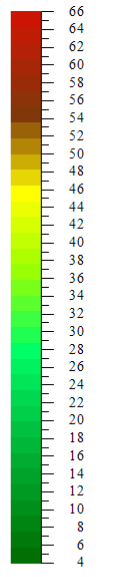
Lothe et al. (2011)



40 Ma



Today



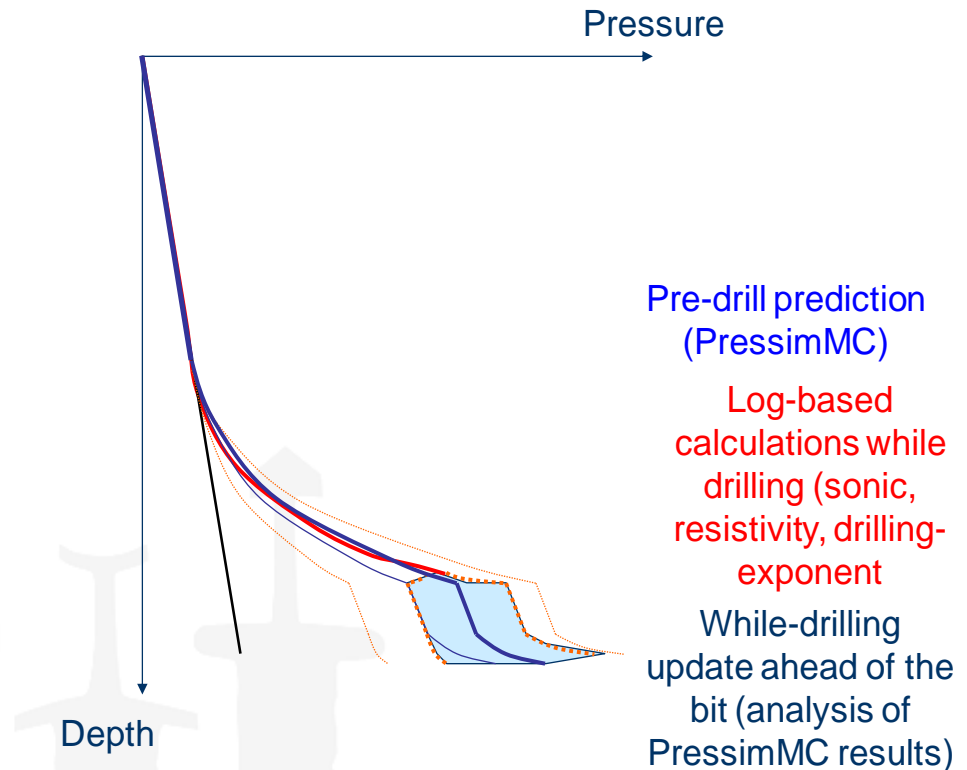
Overpr (bar)

Lothe et al. (2011)

"Pressure Ahead"

Reduced uncertainties in overpressure and drilling window prediction ahead of the bit

- Three years; from 2016-2018
- Total budget is 17,5 mill NOK, where part is financed from the DrillWell Centre (Statoil, Det Norske, Wintershall, ConocoPhillips and Lundin) and from NFR
- Lead by SINTEF Petroleum in collaboration with IRIS, NTNU and Ecole des Ponts, Paris-Tech
- One PhD student



Geophysical imaging methods at SINTEF Petroleum

The geophysics group has since decades been developing and applying advanced imaging methods for exploration and monitoring

Current state-of-the-art methods:

- Seismic wave propagation (3D visco-acoustic/elastic modelling w. anisotropy using TIGER)
- Seismic inversion (ray-based tomography and 2D/3D Full Waveform Inversion)
- 1D and 3D EM inversion
- Joint Inversion (of seismic, EM, magnetic, and gravity data)
- AVO/OptAVO

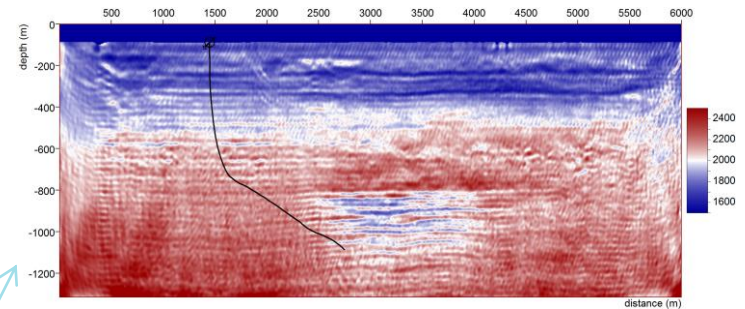


Figure: High-resolution velocity map of subsurface at Sleipner obtained using FWI

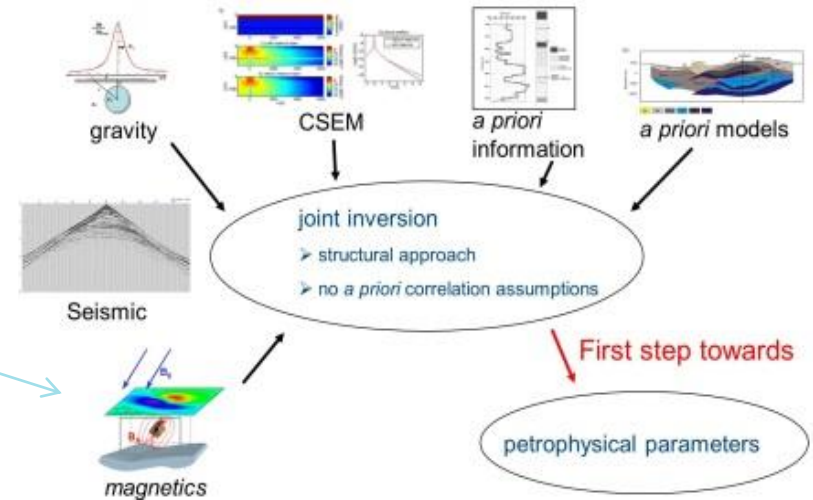
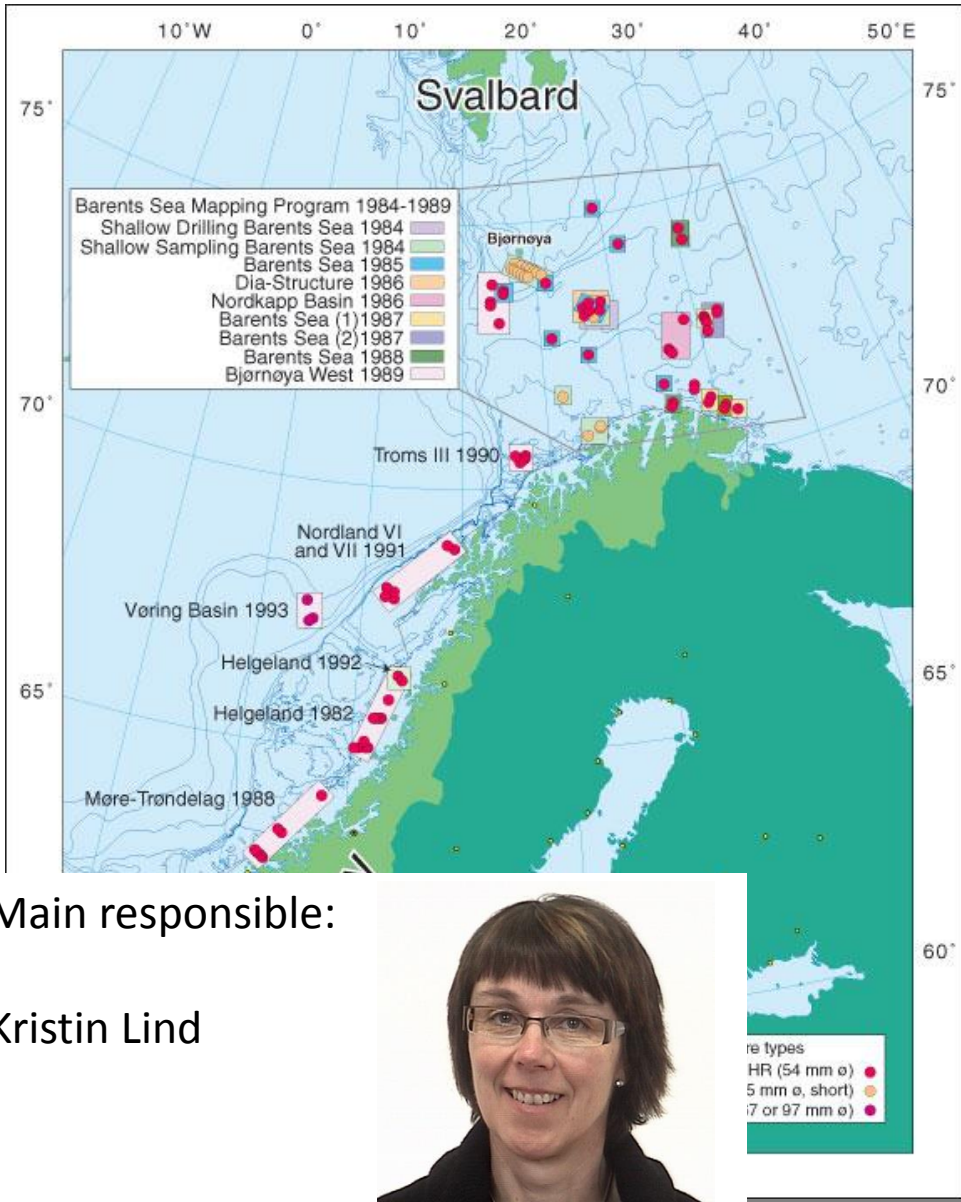


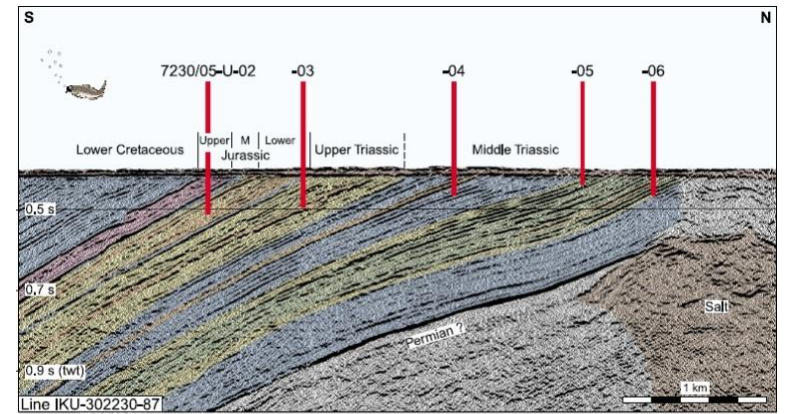
Figure: Joint inversion framework

Stratigraphic Drilling Database



Main responsible:

Kristin Lind



- wireline logging
- full analysis of cores
- stratigraphic correlation
- facies interpretation
- diagenesis & provenance
- source-rock potential, migrated hydrocarbons

About 7 km of core from >90 sites.

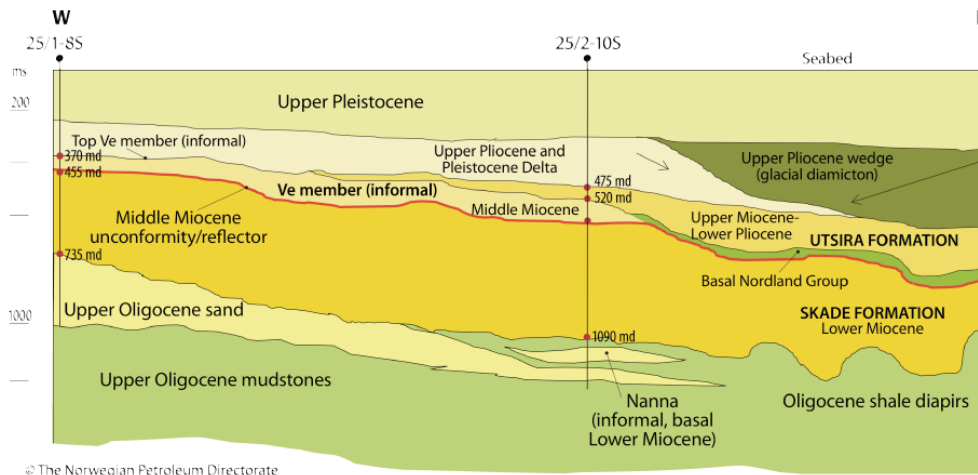


GlaciStore bid:

Joint drilling programme

International cross-boundary initiative towards a climate motivated drilling operation in the North Sea

- CO₂ storage
- Quaternary glacial history



British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL



UiO : **University of Oslo**



UNIVERSITETET I BERGEN



Institute for Energy Technology



Statoil

Lundin
Petroleum



Contact: Maria Barrio

Technology for a better society

Thank you!

