Norsk Regnesentral (NR)
Norwegian Computing Center

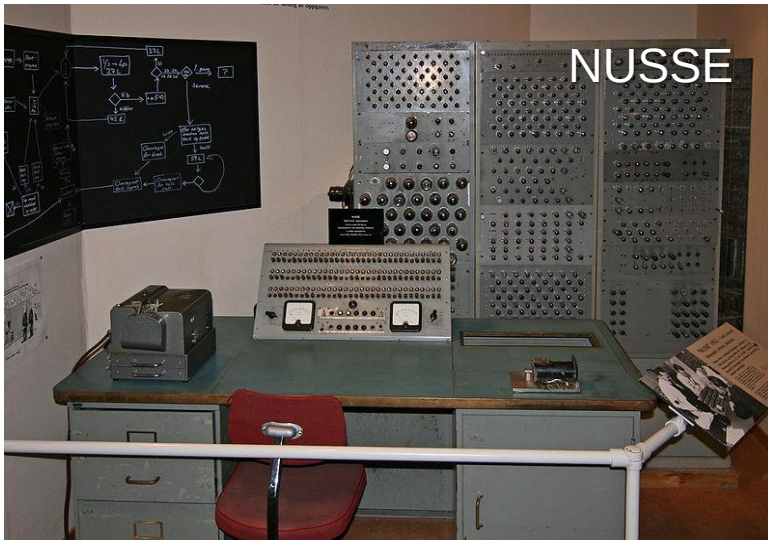
Petter Abrahamsen

Joining Forces 22-23 Mai 2013


NUSSE:
- 512 9-digit numbers
- 200 additions/second

NR is an *applied* research institute

- Established by the government in 1952 to run NUSSE
- **Private** non-profit foundation since 1985
- Financed by:
  - Domestic private companies
  - Public sector
  - Norwegian Research Council
  - EU
  - International companies
- 69 research scientists and 9 staff
- Revenue 82 mill. NOK
  (11 mill. EUR)



NR has three main activities

- Statistical and mathematical analysis and modeling
- Image analysis and pattern recognition
- Information and communication technology (ICT)

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NR works in six main application areas

Statistics for Innovation (sfi)²

Centre for Research-based Innovation

UiO : Universitetet i Oslo

NTNU
Innovation and Creativity

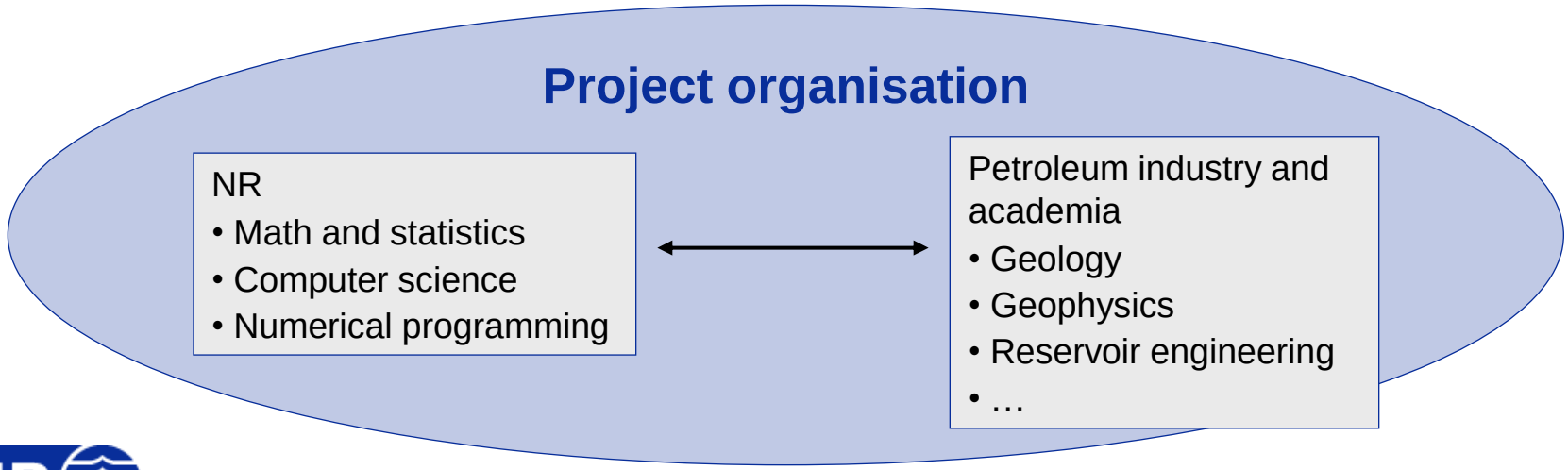
NR

The SAND (Statistical Analysis of Natural Resources) group

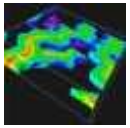
- One of 3 research groups at NR
- Currently 18 persons
  - 9 PhD's
  - 2 PhD students
  - Background from math, statistics, physics, and computational chemistry
- 350+ conference contributions and journal articles
- Main markets are
  - National oil companies
  - International oil companies
  - Roxar Software Solutions
  - National research institutes
  - Public science funding including EU

Key competence

- Math, statistics and stochastic modelling
  - Geostatistics, spatial statistics, stochastic simulation, data analysis, data integration, Bayesian methods, Markov chain Monte Carlo
- Software implementation
  - C++, Matlab, R, Excel (+@Risk)

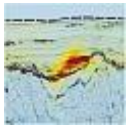


Main research areas



Petroleum reservoir models

Structural geology

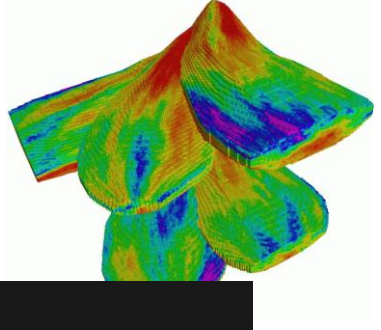


Inversion of geophysical data

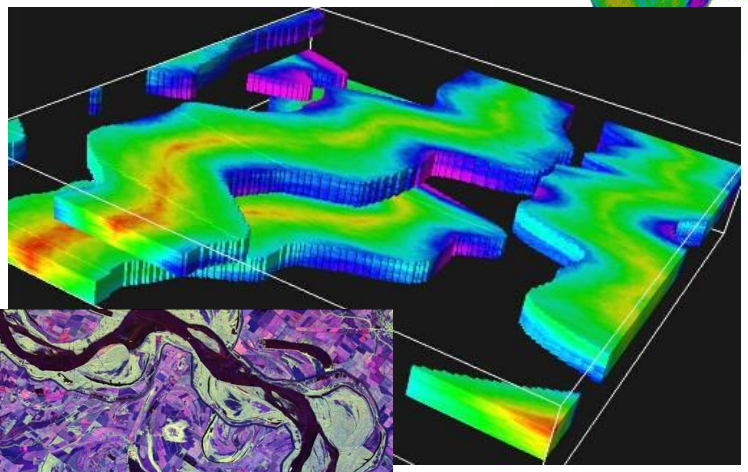
History matching and dynamic data

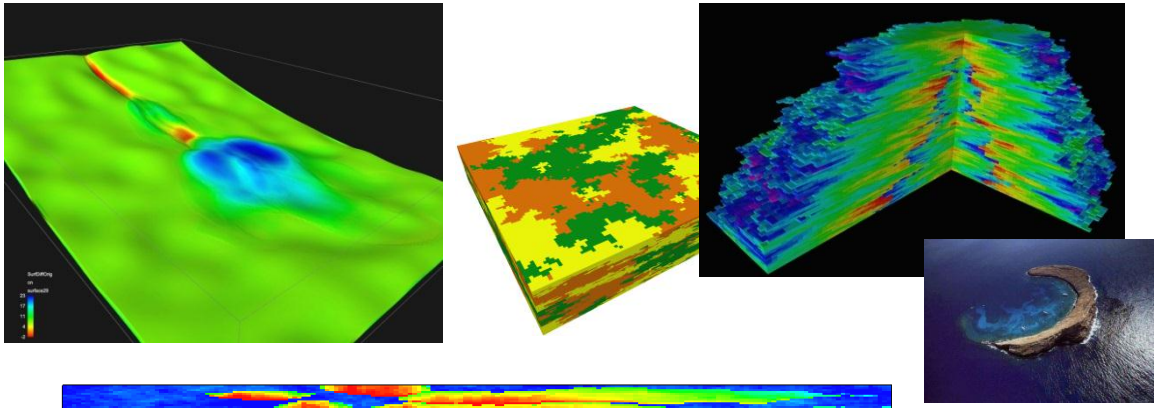
Decision support and data analysis

Petroleum reservoir models



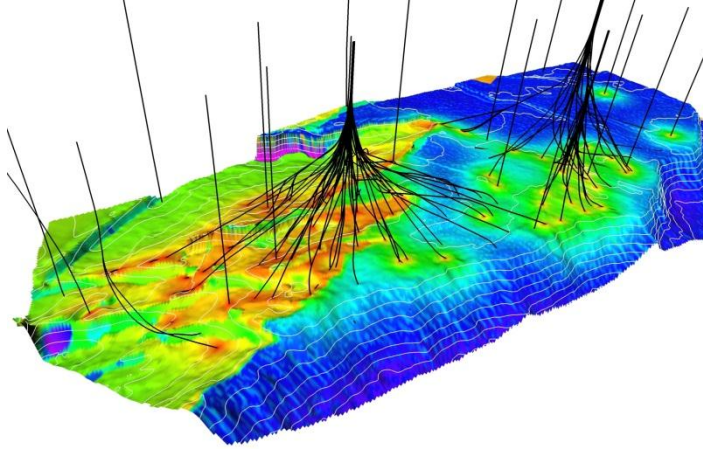
- 3D heterogeneity models for
  - Fluvial deposits
  - Shallow marine
  - Turbidites
  - …
- Consistent with data
  - Wells
  - Seismic data
- Challenges:
  - Process models
  - Speed
  - Ease of use

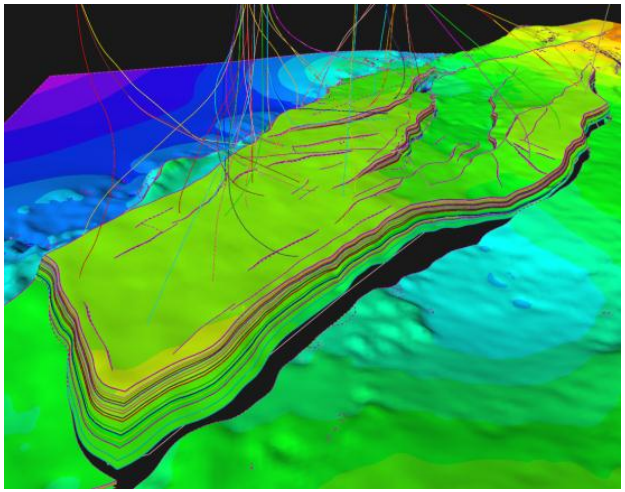


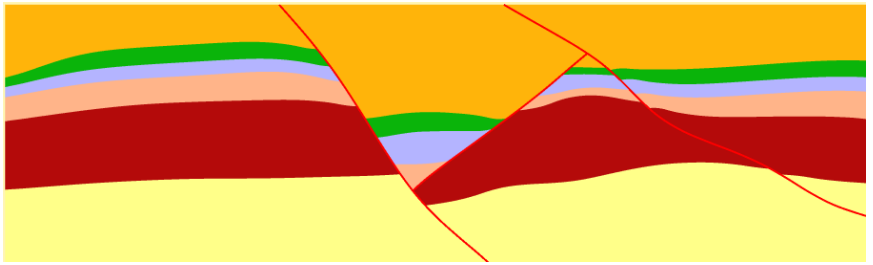


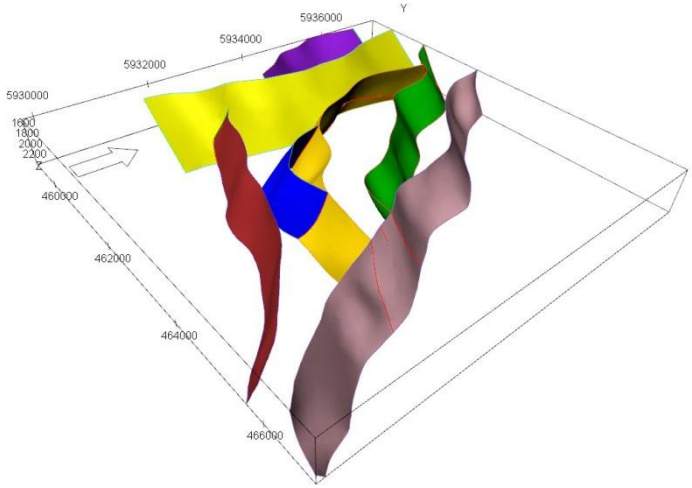
Structural geology

- Surface modelling
  - Depth conversion
  - Horizontal wells
  - QC
- Fault modelling
  - Uncertainty
  - Perturbations
  - Automatic



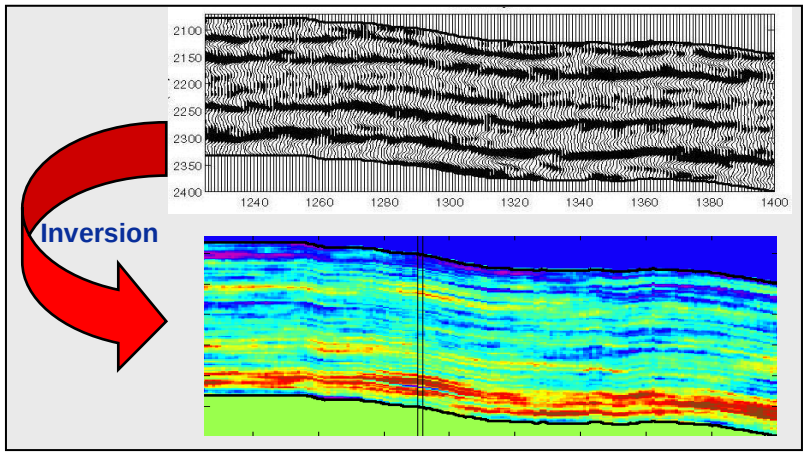


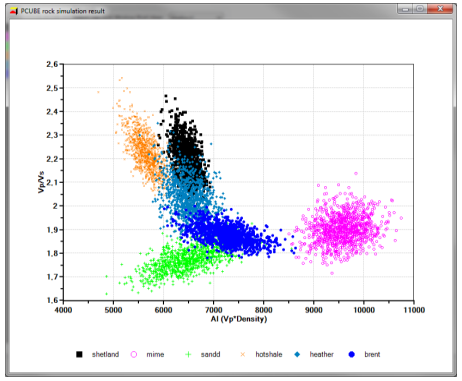


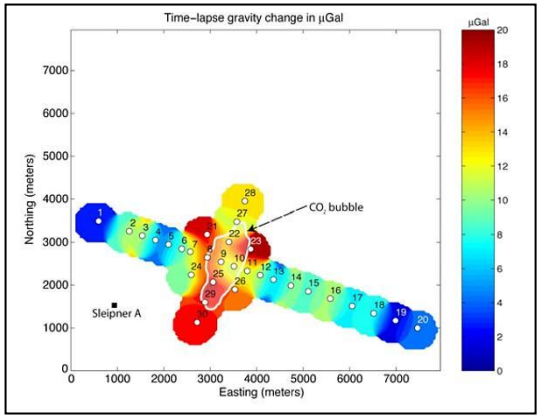


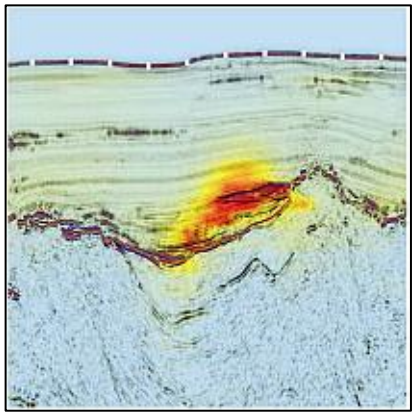
Inversion of geophysical data

- Inversion
- Rock physics
- Time lapse
- Challenges:
  - Resolution
  - Ambiguity
  - Consistency
  - Uncertainty





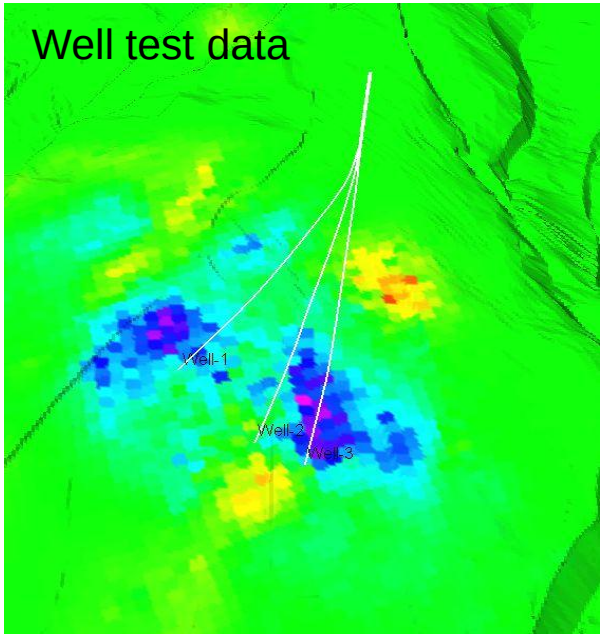


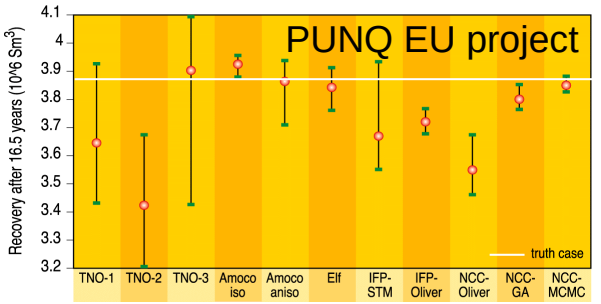


History matching and dynamic data

- Major challenge:
  - Condition 3D geomodels to dynamic data (history matching)
  - Well tests
  - Reproduce connectivity

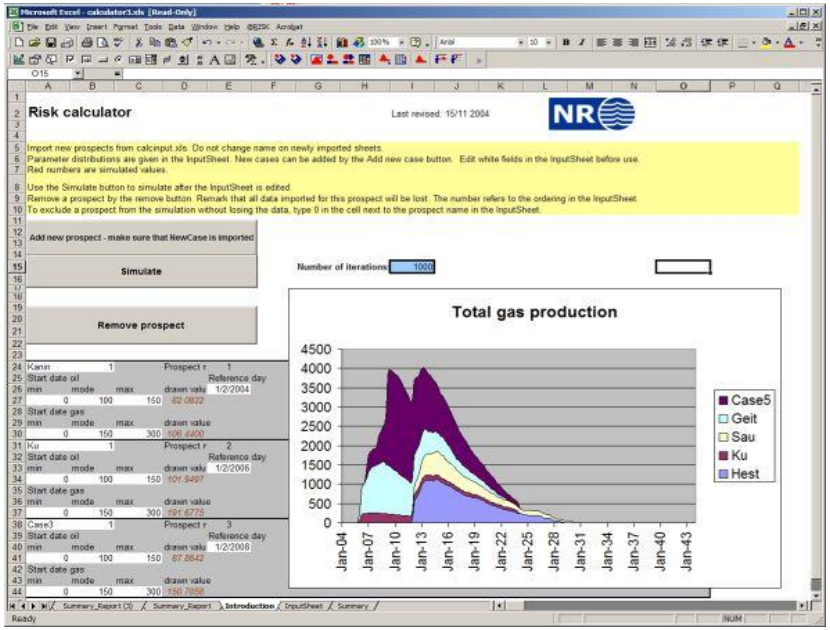
- Some approaches:
  - Ensemble Kalman filter (and other smoothers)
  - Modify geomodel in near-well area



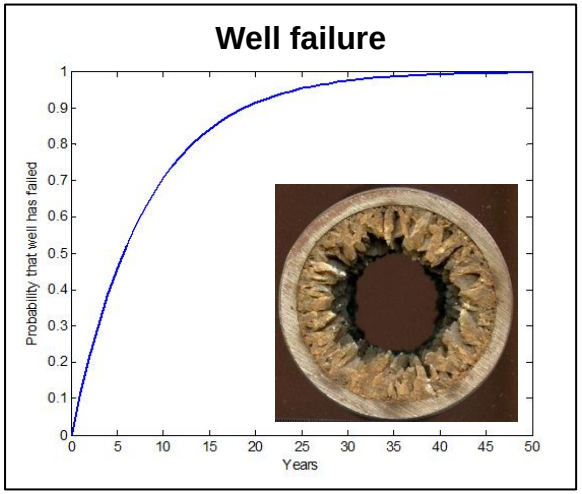


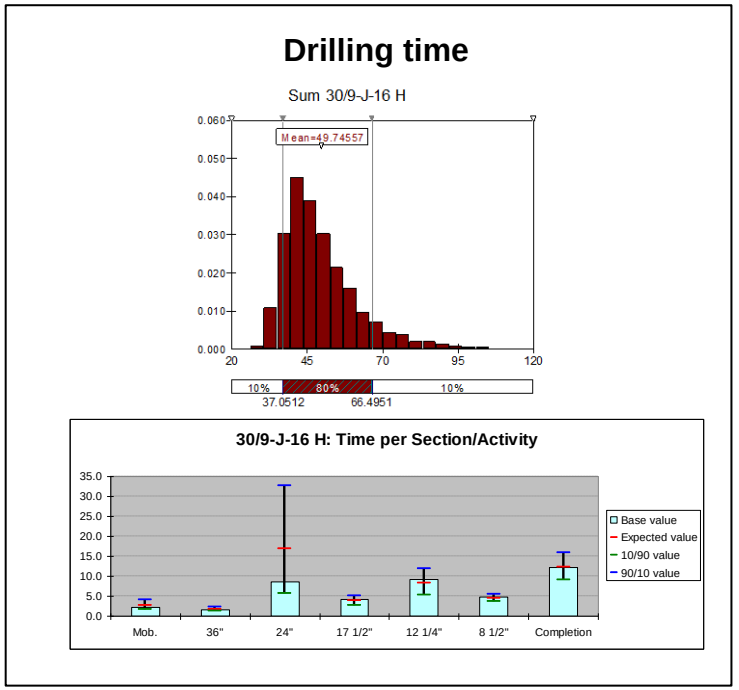
Decision support and data analysis

- Uncertainty modelling
  - Combine scenario and Monte Carlo analysis
  - Correlations in portfolios
  - Time dependency



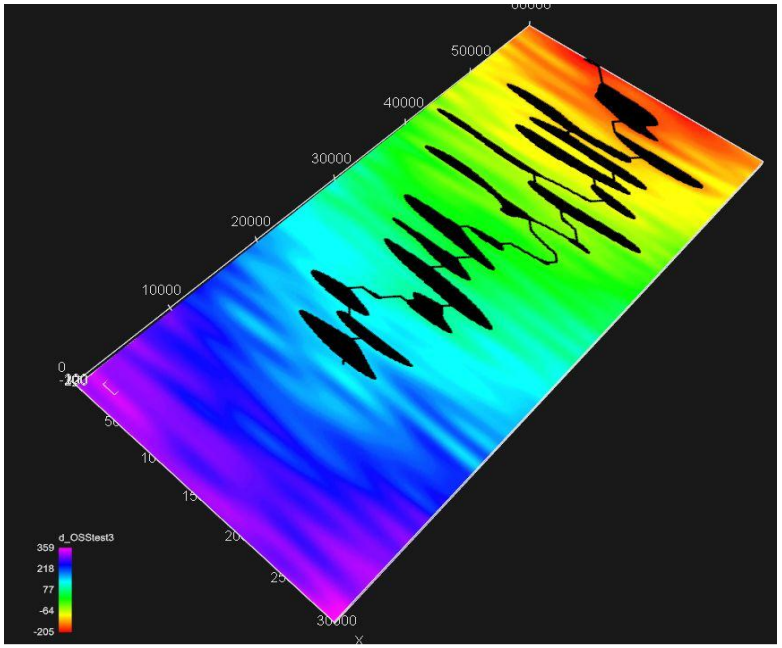
- Data analysis

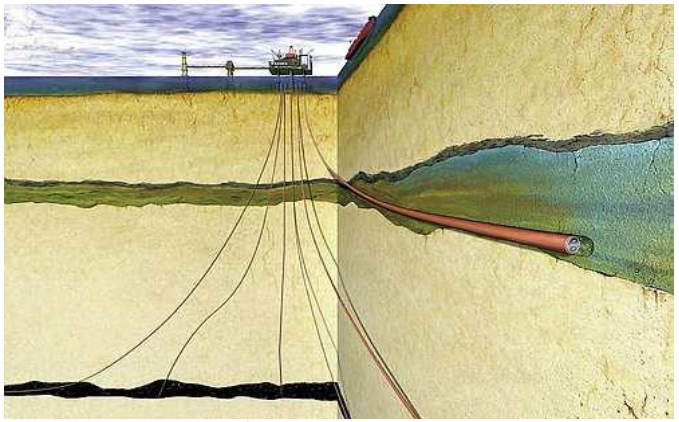


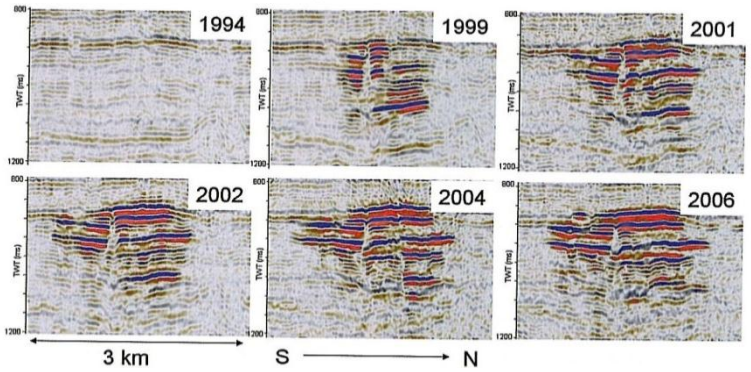


CO_2 storage

- Predict capacity
- Leakage risk
- Monitoring







So we know math/statistics but work in G & G applications…

Cooperate with vendors, oil companies, research institutes and universities

CIPR

TuMod – Turbidite Modelling

- **Objectives:**
  - Develop methodologies, algorithms, and software tools for modelling deep-water (turbidite) reservoirs.
  - Combine stochastic modelling approaches with process based models that describe the appropriate sand-body geometries.

The Research Council of Norway

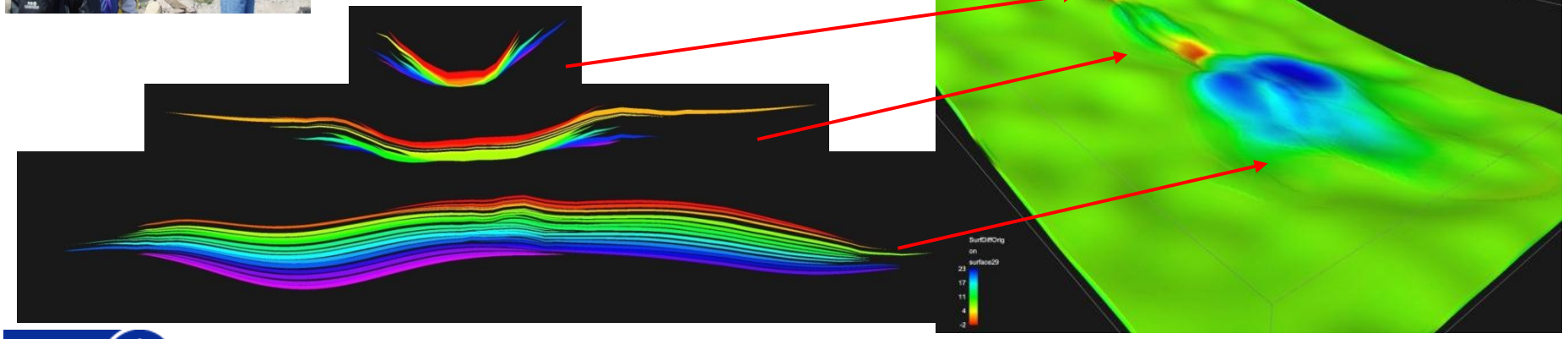
Norwegian Centre of Excellence CIPR

ConocoPhillips

Statoil

CFD Complex Flow Design

- **Challenges:**
  - Diversity in phenomenon
  - Scale (1km – 1000 km)
  - Data (none – a lot)



NR

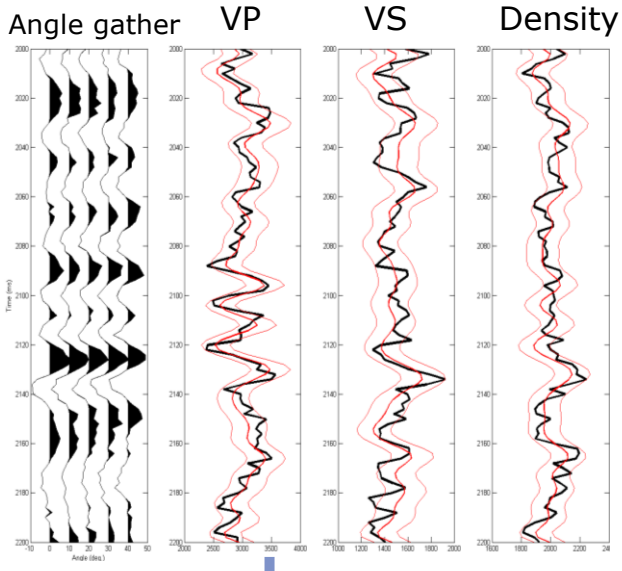
- Buland, A., and H. Omre, 2003, Bayesian linearized AVO inversion: Geophysics, 68, 185-198
- Buland, A., Kolbjørnsen, O. Hauge, R., Skjæveland, Ø., and Duffaut, K, (2008) Bayesian lithology and fluid prediction from seismic prestack data: *Geophysics* 2008 ;Volum 73.(3) s. C13-C21

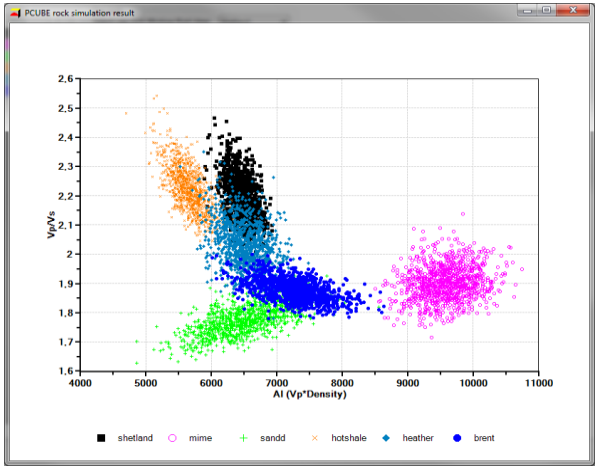
Probability for HC

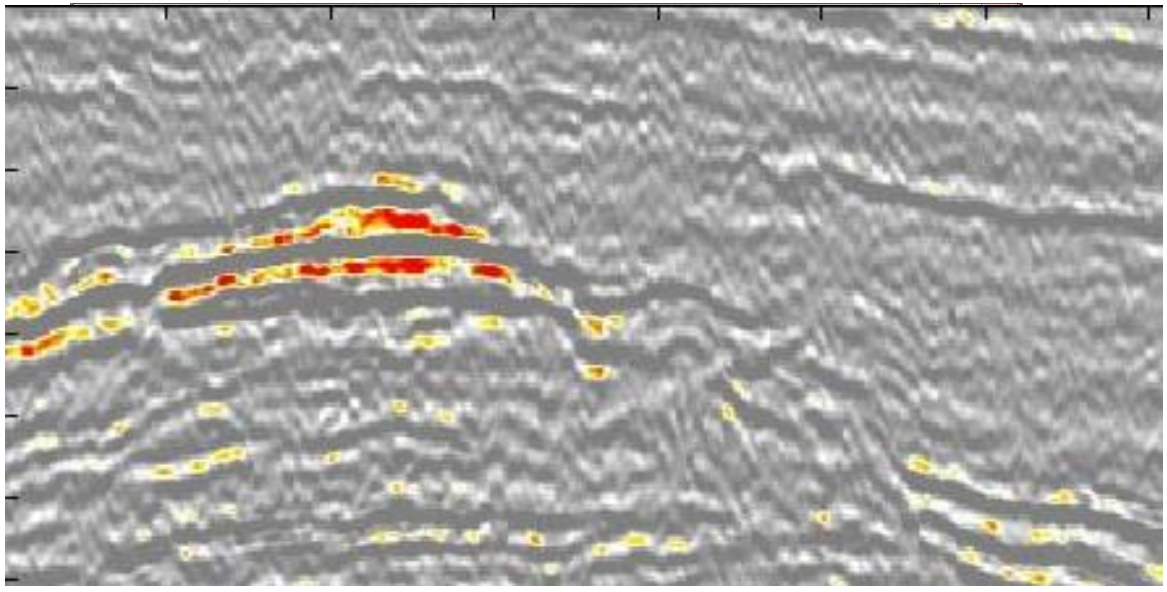
Statoil

Integration of knowledge:

- Seismic amplitudes
- Conseptual model
- Rock physics







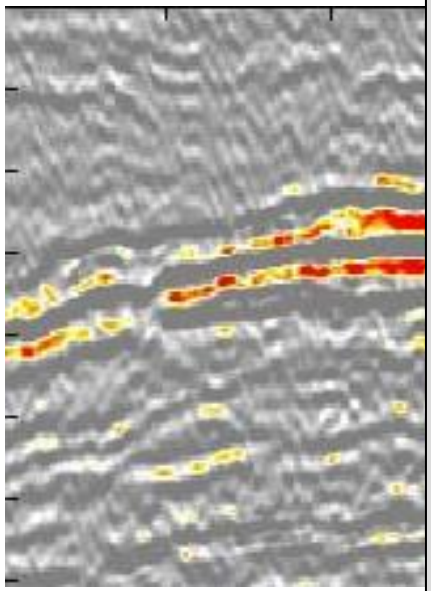
Output:

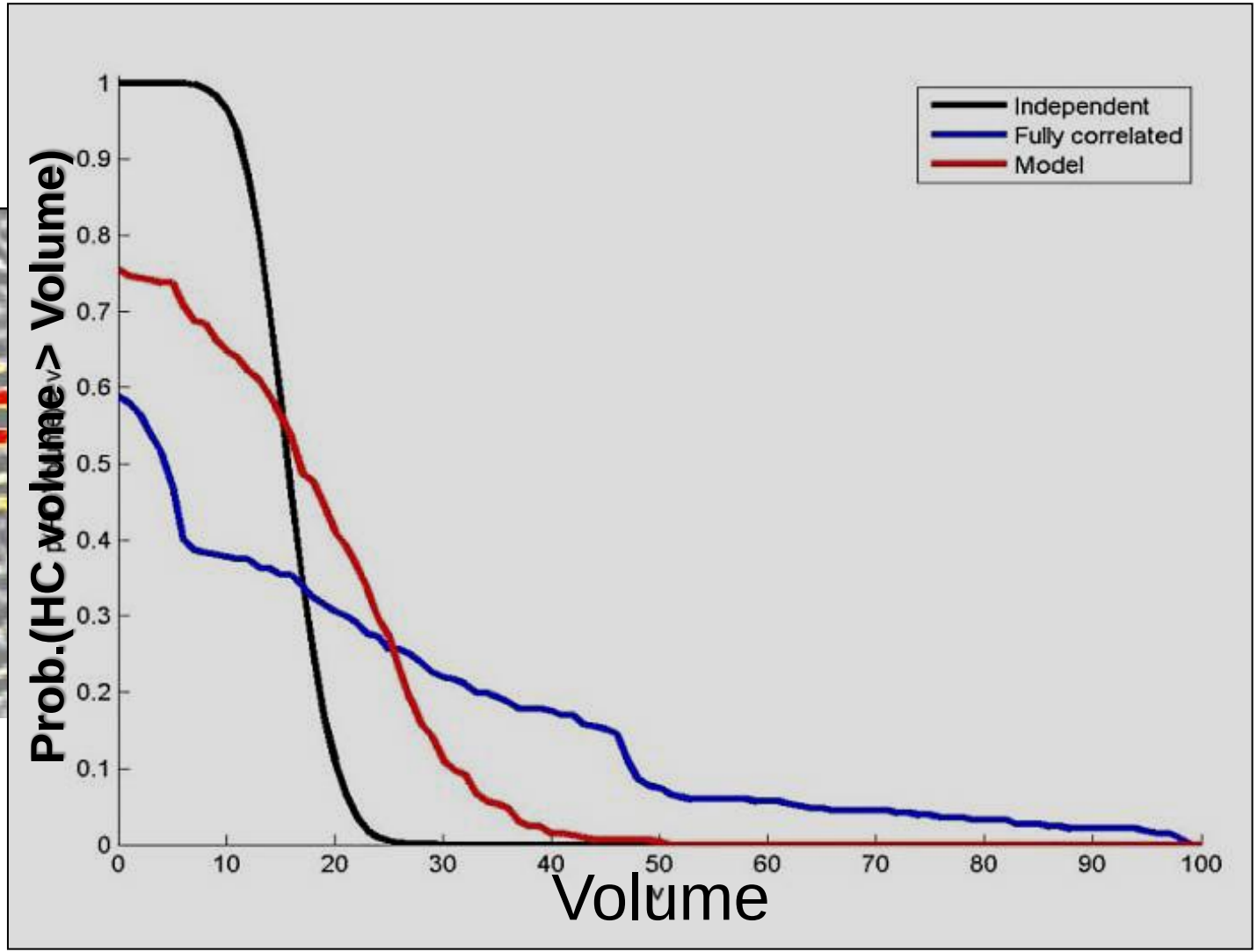
- Probabiility of Lithology and fluid classes.

NR

Project proposal:
Using Geological 3D Models to Improve Risking of Hydrocarbon Prospects

DHI





Project proposal:
Using Geological 3D Models to Improve Risking of Hydrocarbon Prospects

Objectives:
The primary objective of the project is to develop accurate methods for calculating the probability for a certain amount of oil, condensate, or gas in a given prospect constrained by geological assumptions, rock physical knowledge and data from a seismic survey.

Secondary objectives:
1. Establish a stochastic model describing uncertain geology that can efficiently be constrained by seismic data.
2. Develop methods for verifying the statistical model.
3. Develop a method for stochastic inversion to lithology realizations for general classes of discrete spatial distributions.
4. Obtain volume distributions (risked volume) for specific fluid scenarios, by combining objective 3 with travel time and zone probability inversion.
5. Find fluid scenario probabilities.
6. Develop methods for assessment of the quality of algorithmic approximations.
7. Use the probability distributions for hydrocarbon to improve placement of drilling targets in the exploration and appraisal phase.
8. Educate 1 PhD or postdoc.

We have two sponsors but need one more.

NR NTNU Innovation and Creativity STANFORD UNIVERSITY

We have

- Highly skilled professionals
- Unique competence
- Long history of successful projects
  - Research (publications, presentations, PhD's,…)
  - New methods
  - Case studies
  - Commercial software

Thank you for your time