Centre for Integrated Petroleum Research

Jan Tveranger

Mission statement
Be an internationally leading centre for innovative solutions aimed at maximizing recovery and increasing recoverable reserves in existing oil and gas fields.

Jan.tveranger@uni.no
Uni CIPR
Allégt. 41
5007 Bergen

+ 47 55 58 36 64

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Joining Forces Seminar
Stavanger, 22-23 May 2013

Who are we?

KEY FIGURES

OWNERS

University of Bergen
85%

Bergen Research Foundation
15%

COMPANY

uni Research

500 employees
Annual turnover 400 MNOK

DIVISIONS

Uni Health
Uni Computing
Uni Rokkan Centre
Uni Bjerknes
Uni Environment
Uni Sars Centre
Uni CIPR → 70 researchers + 70 students; Annual turnover 60 MNOK

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CIPR research and links to other centres

PETROLEUM		Only Norwegian Centre of Excellence in petroleum research (2003-2013). Partners: UoB and Uni Research
CO_2 STORAGE		Scientific leadership of the SUCCESS-FME research in the Bergen Region
GEOTHERMAL HEAT		Partner in CGER- FME
OWF PLANNING		Partner in NORWCOWE-FME
	Norwegian Center for Improved Oil Recovery	Application for hosting this centre will be submitted together with the Universtiy of Bergen in May 2013

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G&G and reservoir engineering at Uni CIPR

CIPR's main focus is on maximizing oil recovery.

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SECTIONS

- Improved and enhanced oil recovery
- Reservoir simulation
- Geoscience

DISCIPLINES

- Geology
- Geophysics
- Chemistry
- Physics
- Mathematics

Main tool is applied, integrated, cross-disciplinary research.

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Key competencies and strenghts

Key competencies:

-Reservoir characterization and modelling
-Simulation methods
-Enhanced oil recovery methods
-Reservoir monitoring

Key strengths:

-Integrated, cross-disciplinary approach
-Staff with both academic and extensive industrial experience
-Emphasis on applied research
-Close co-operation with and proximity to University of Bergen
-Extensive national and international network of collaborating institutes, Universities and individual researchers

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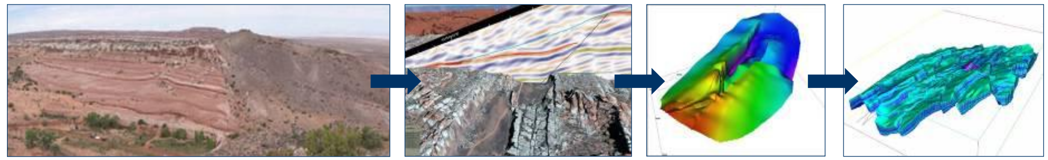
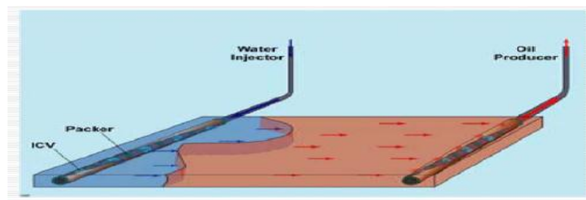
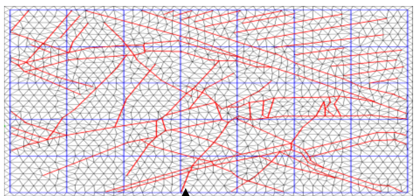
Areas of recent, current and potential future research activities

Reservoir characterization
Best reservoir model
Reservoir communication

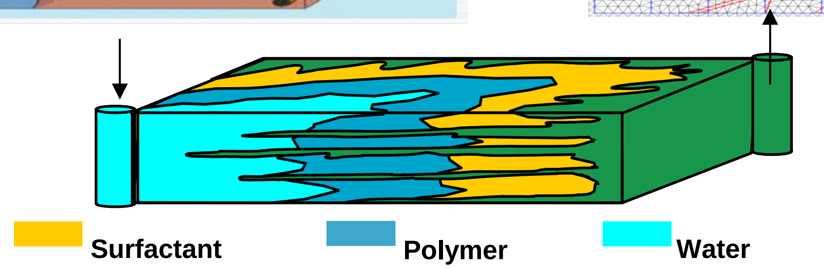


Simulation methods
Better predictions



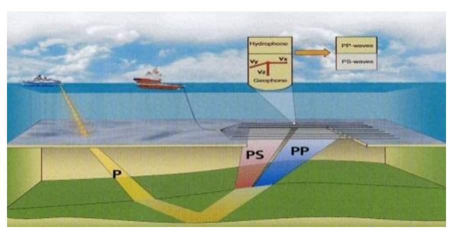


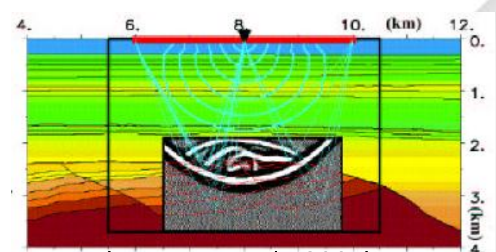
Enhanced oil recovery methods
Move trapped oil
Sweep improvement



- Surfactant
- Polymer
- Alkaline
- Foam

Monitoring
Find best drilling targets





(Lecomte et al., 2004)

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Reservoir characterization

- Quantification of geological features for modelling purposes
  - Depositional architectures; modern and ancient (e.g. SAFARI)
  - Fault zone architectures (e.g. Fault Facies), fracture zones
  - Paleokarst reservoirs
  - Bedrock reservoirs

- Aquisition methods for outcrops and cores
  - LIDAR imaging, processing and interpretation
  - Hyperspectral scanning of outcrops
  - Hyperspectral core scanning

- Geo modelling
  - Tools and workflows for explicit modelling of fault zones (Fault facies)
  - Study and quantify impact of geological features on fluid flow

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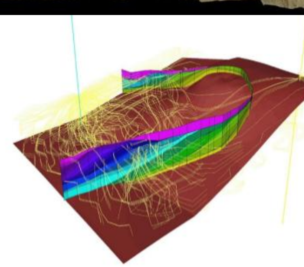
Outcrop analogues and databases

- Analogues show reservoir structures and properties not resolvable through seismic and well data
- Collection, processing and analysis of sedimentological and structural properties, features, architectures
- Resulting databases provide key input to reservoir modelling and uncertainty evaluation



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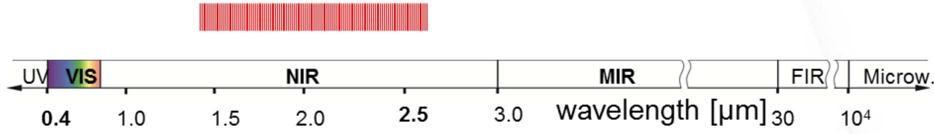
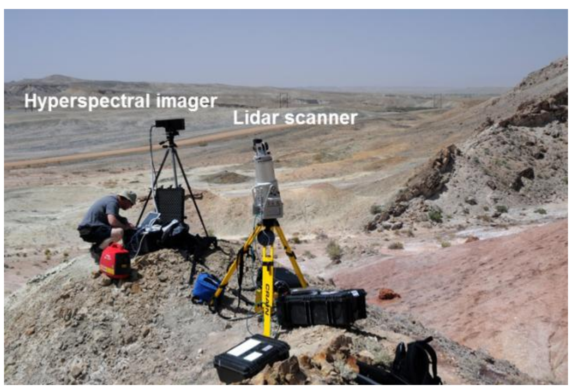
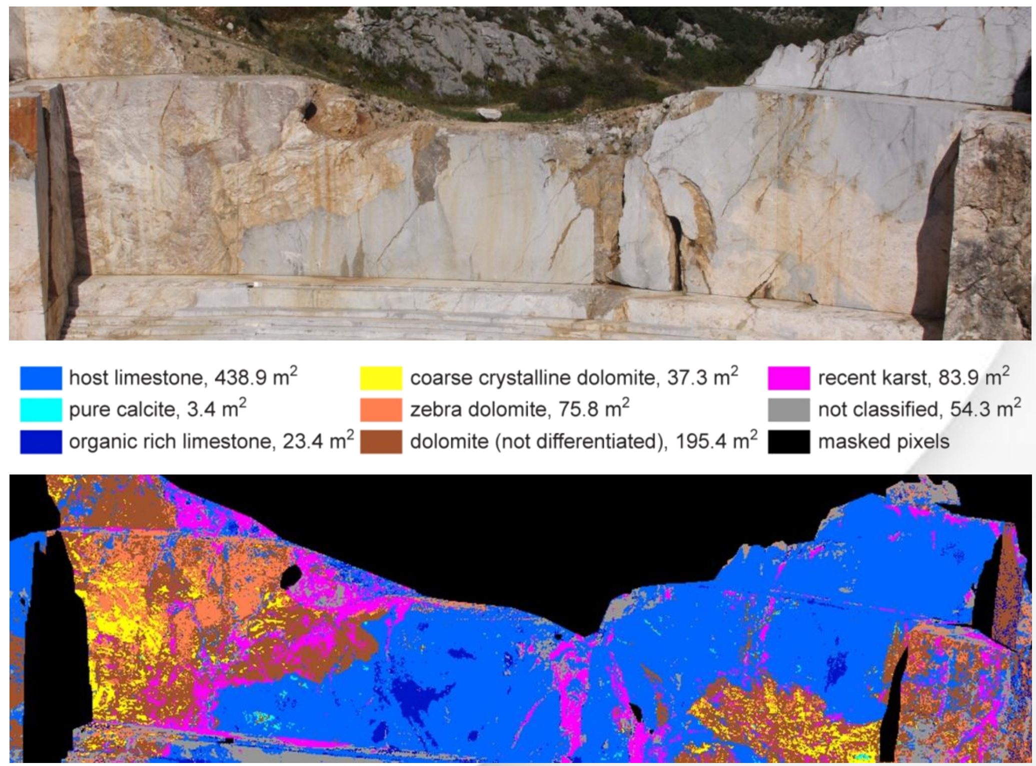
Hyperspectral imaging



- Hyperspectral images provide mineral-chemical information

- Reflectance properties are used for mineral identification
  - Materials show diagnostic absorption properties due to specific ions such as carbonate and hydroxyl ions in the crystal lattice
  - Position and shape of the absorption features allow to identify minerals such as different carbonate and clay minerals





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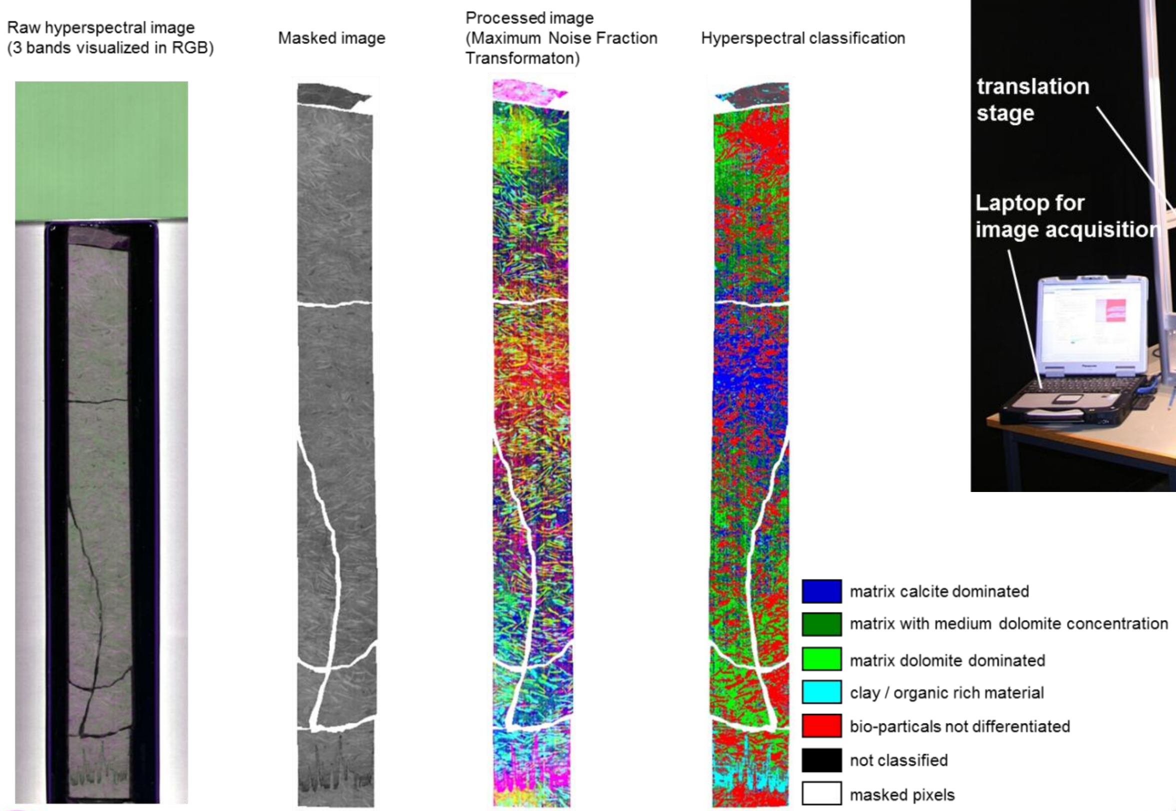
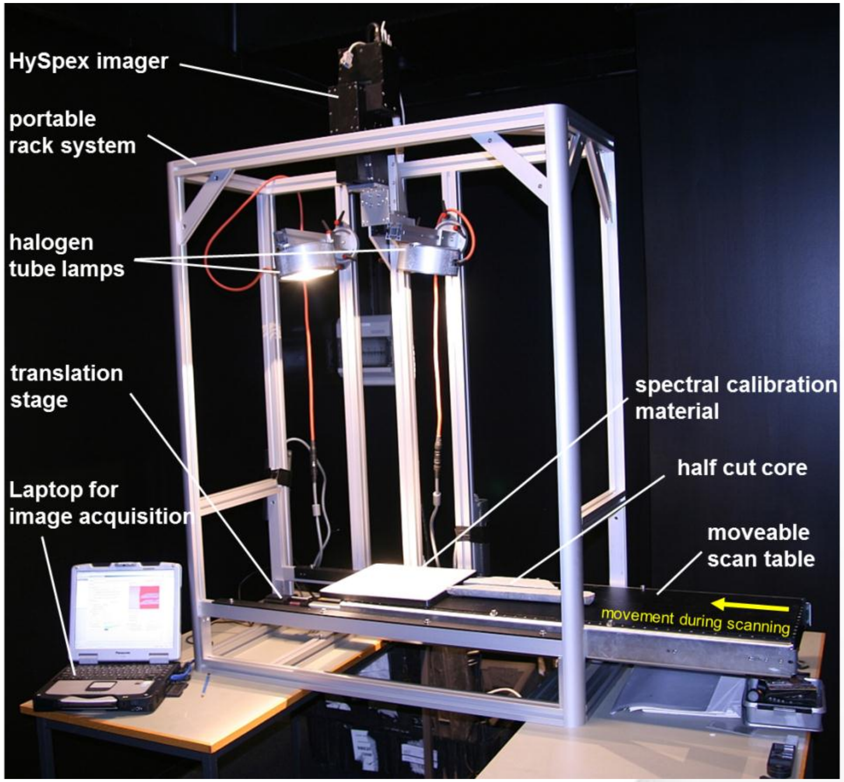
Hyperspectral core scanning

- Continuous logging
- Captures diagenetic subtleties
- Facilitates improved sampling
- Portable rig currently undergoing verification





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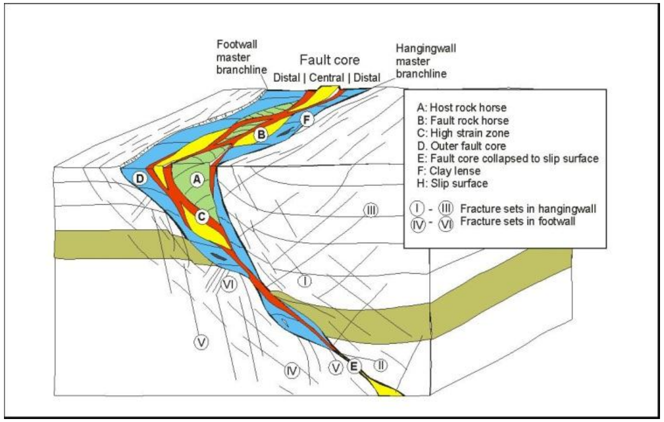
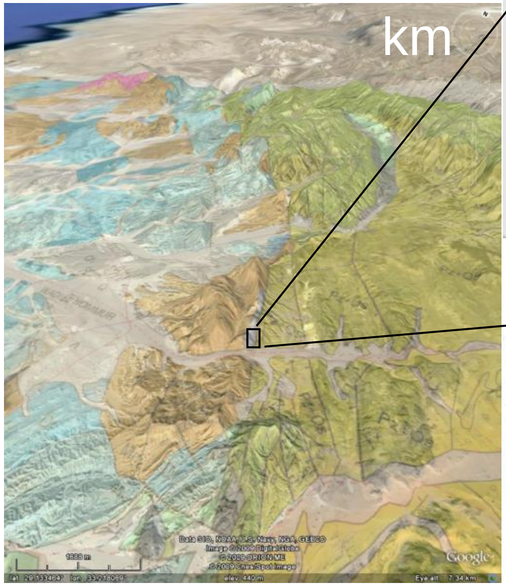
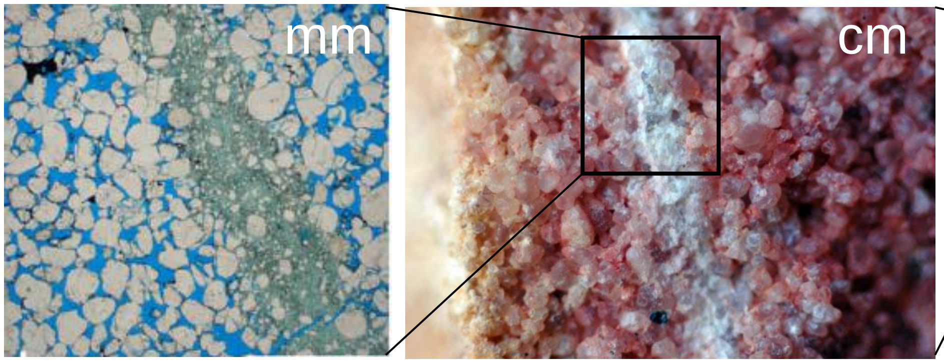
Multiscale, quantitative characterization of faults





- Classification
- Geometries and architecture
- Petrophysical properties
- Processes



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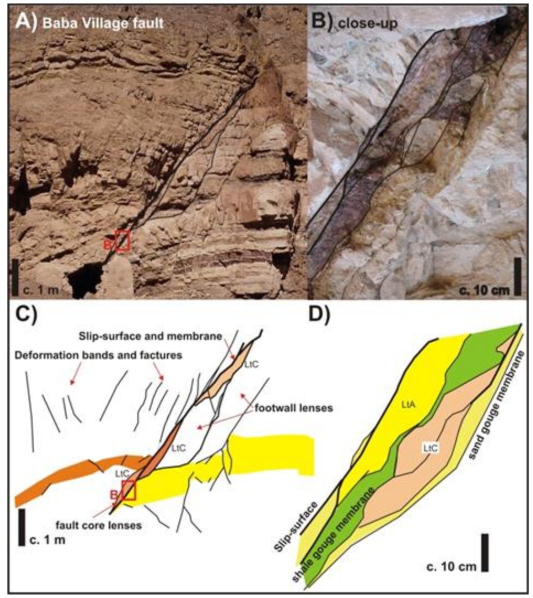
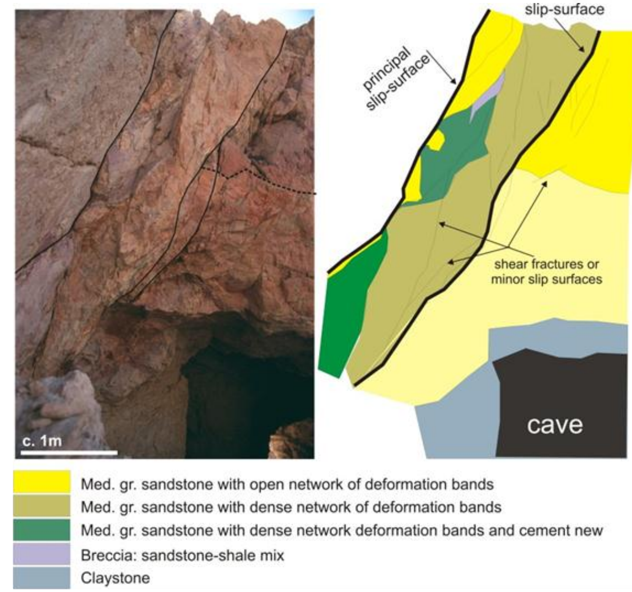
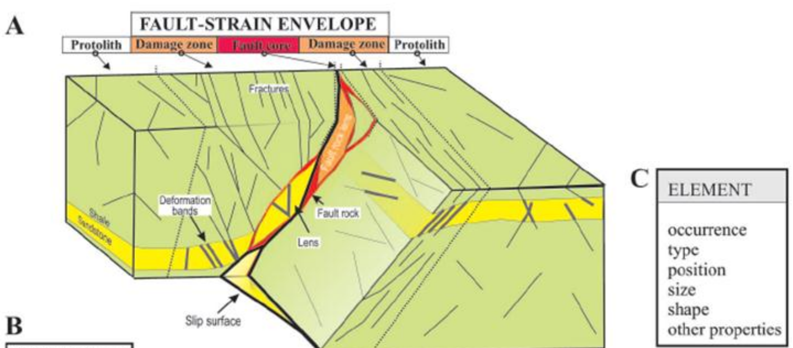
Fault facies classification







B

Fault envelope

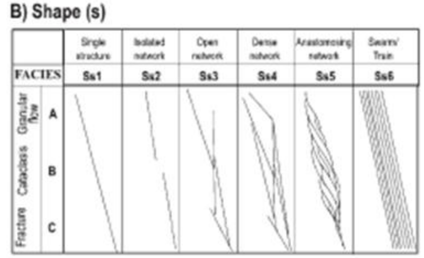
STRAINED ROCK VOLUME	ZONING		APPEARANCE	TYPICAL ORIENTATION
	Fault core	Damage zone		
ELEMENTS	deformation band	deformation band	millimeter tabular zone	Riedel sets
	slip surface	slip surface	cohesion-free discontinuity	parallel with fault
	fracture	fracture	cohesion-free discontinuity	Riedel sets
	cleavage	cleavage	disolution and mineral orientation surface	parallel with fault or fold surface
	stylolith	stylolith	disolution surface	parallel with fault or fold surface
	fault-rock layer		deformed host-rock layer along fault	parallel with fault
	shale smear		smeared shale layer along fault	parallel with fault
	sand smear		smeared sand layer along fault	parallel with fault
	mixed unit	mixed unit	layer of mixed sand-shale	parallel with fault
	membrane		layer of fault rock or smear along fault	parallel with fault
	lens	lens	tectonic body of host or fault rock	long axis parallel with fault

Slip surface, fractures, and deformation bands (S)

A) Type (Ssl = slip surface, Sfr = fracture, Sdb = deformation band)

Sharp				Tabular
	FACIES			
Fractures	Ssl	Sfr	Sdb	Deformation bands
R	Ssl1	Sfr1	Sdb1	Extensional shear band
R'	Ssl2	Sfr2	Sdb2	
Y	Ssl3	Sfr3	Sdb3	Shear band
P	Ssl4	Sfr4	Sdb4	Contractional shear band
Joint	T	Sfr5	Sdb5	Dilation band
Solution surface	So	Sfr6	Sdb6	Compaction band

B) Shape (s)



A) Type (t), with Cement (-C)

	FACIES
Breccias (with clasts)	Mt1
Sand gouge	Mt2
Shale gouge	Mt3
Sand smear	Mt4
Shale smear	Mt5

B) Appearance / Shape (f, c)

Continuity		Fault rock	Cement
Appearance	%	FACIES	
Continuous	100	Mf1	Mc1
Semicontinuous	90–100	Mf2	Mc2
Ruptured	50–90	Mf3	Mc3
Patchy	10–50	Mf4	Mc4
Pocket	< 10	Mf5	Mc5

(Braathen et al., 2009)

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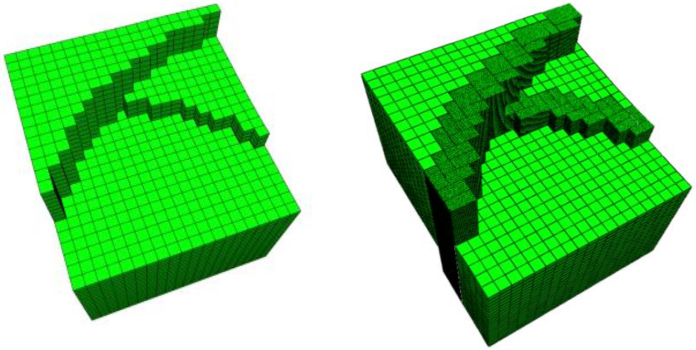
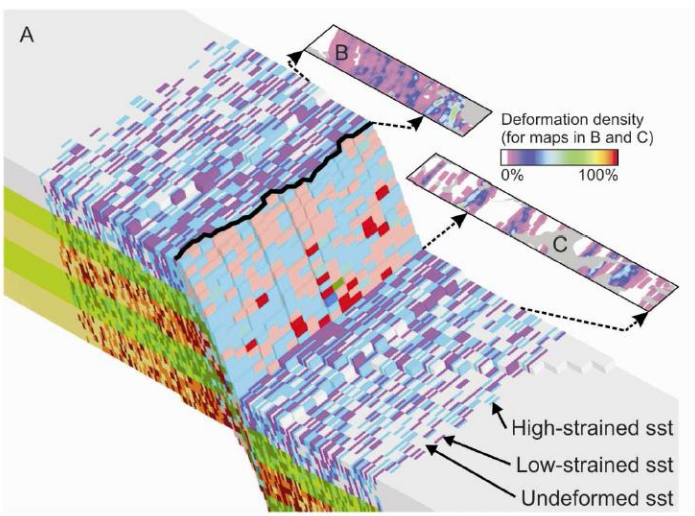
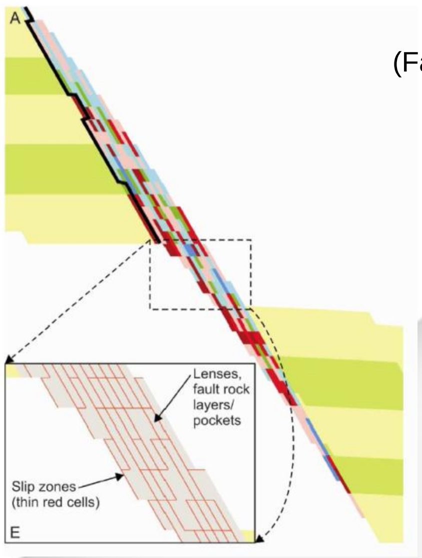
Fault facies modeling

- Volumetric gridding of fault zone
- Characterization of elements and properties
- Conditioning parameters for fault facies distribution







(Fachri et al.,in press)

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Fault Facies

Eastern and Central Barents Sea – karst related secondary porosity in Paleozoic strata

Subsurface characterization of paleokarst reservoirs

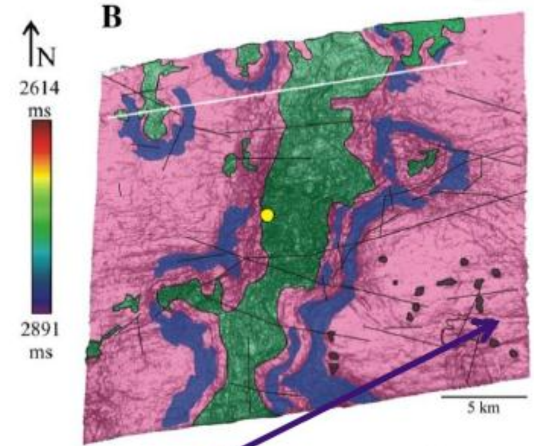
- The structure and properties of Paleozoic carbonates in the Barents Sea are known to exhibit evidence of having been affected by karst and karst collapse processes. Mapping and forecasting the resulting structures and properties is crucial for planning exploration wells as well as optimizing production

Objectives:

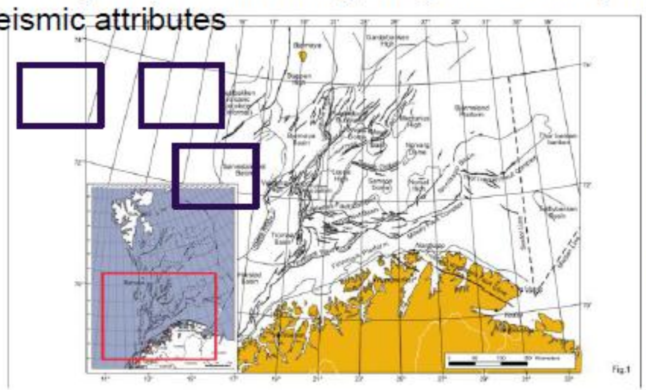
- Identify characterize and classify seismic resolvable paleokarst features in the region
- Establish links between stratigraphy, paleogeography, tectonic features and distribution of paleokarst features

Methods:

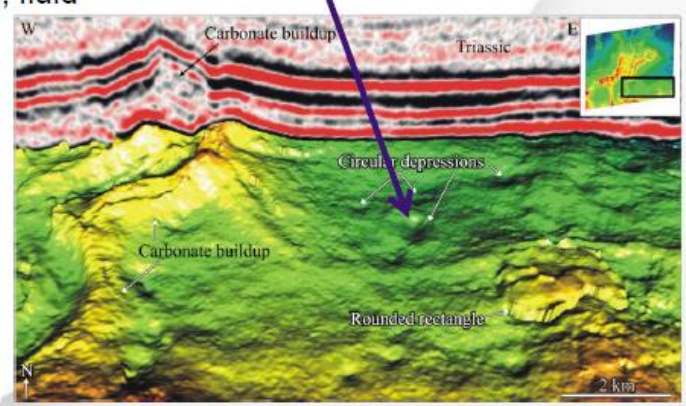
- Interpretation of 3D seismics from representative areas (Norsel High/finnmark platform, Loppa high a.o.)
- Identify relation between carbonate buildups, faults underlying evaporite beds depth, relation to uplifted area (Permian subaerial exposure or other processes)
- Perform seismic characterization paleokarst features (Amplitude, variance, dip and fault enhancement attributes)
- Link core data + additional core analysis (core scanning, diagenesis analysis, fluid inclusion, isotope studies) to seismic attributes



Karst pipes?



Structural map Barents sea, Gabrielsen et al. 1990)



Seismic variance maps showing potential karst areas in the Finnmark platform, from Rafaelsen et al. (2008)

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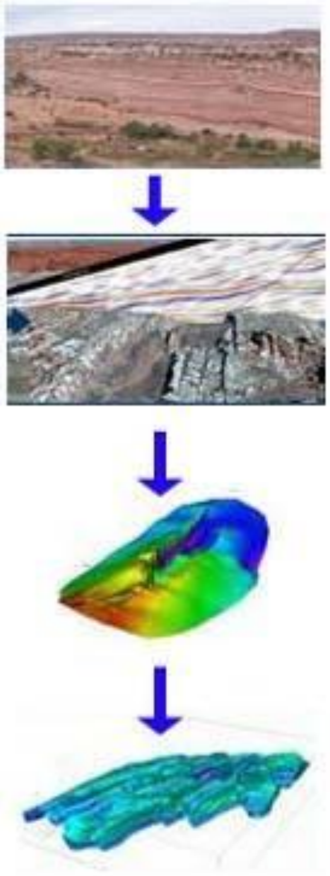
Simulation methods

- Improved reservoir simulation
  - Discretization techniques
  - Compositional simulation
  - Coupled reservoir simulation and geomechanical modeling
  - CO_2 modeling of different scales
  - Coupled reservoir simulation and geochemical modeling
  - EOR modelling on different scales



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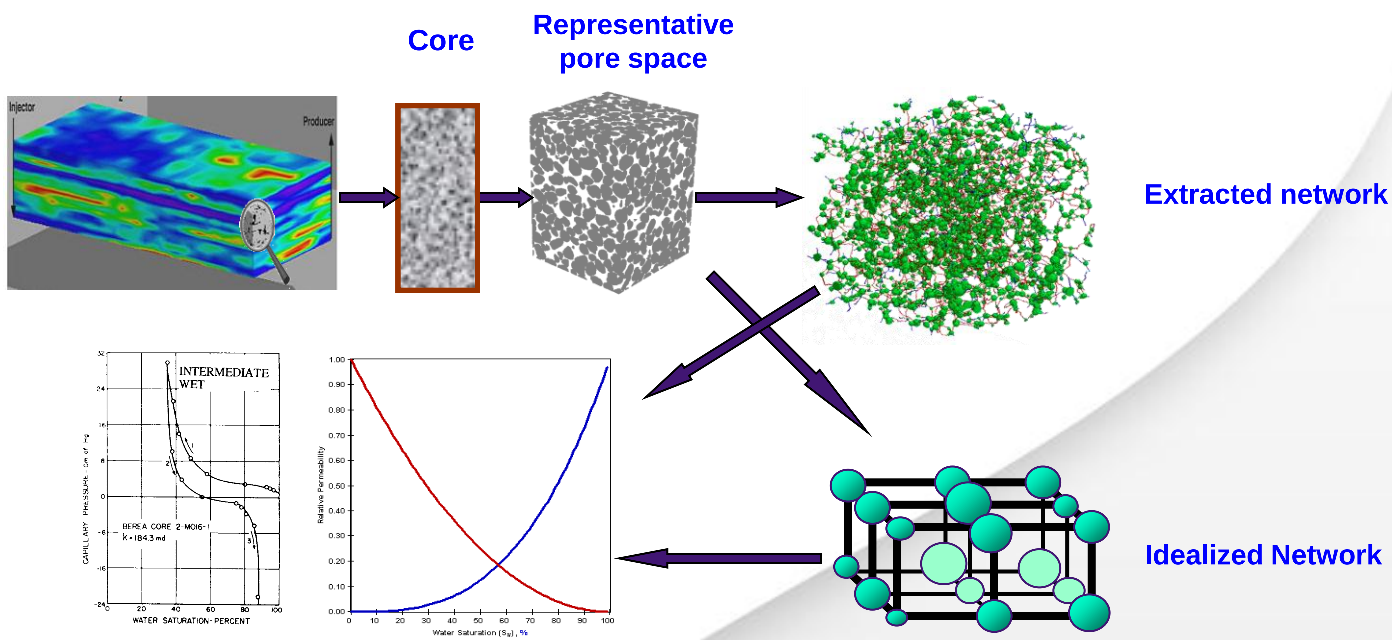
Enhanced recovery methods

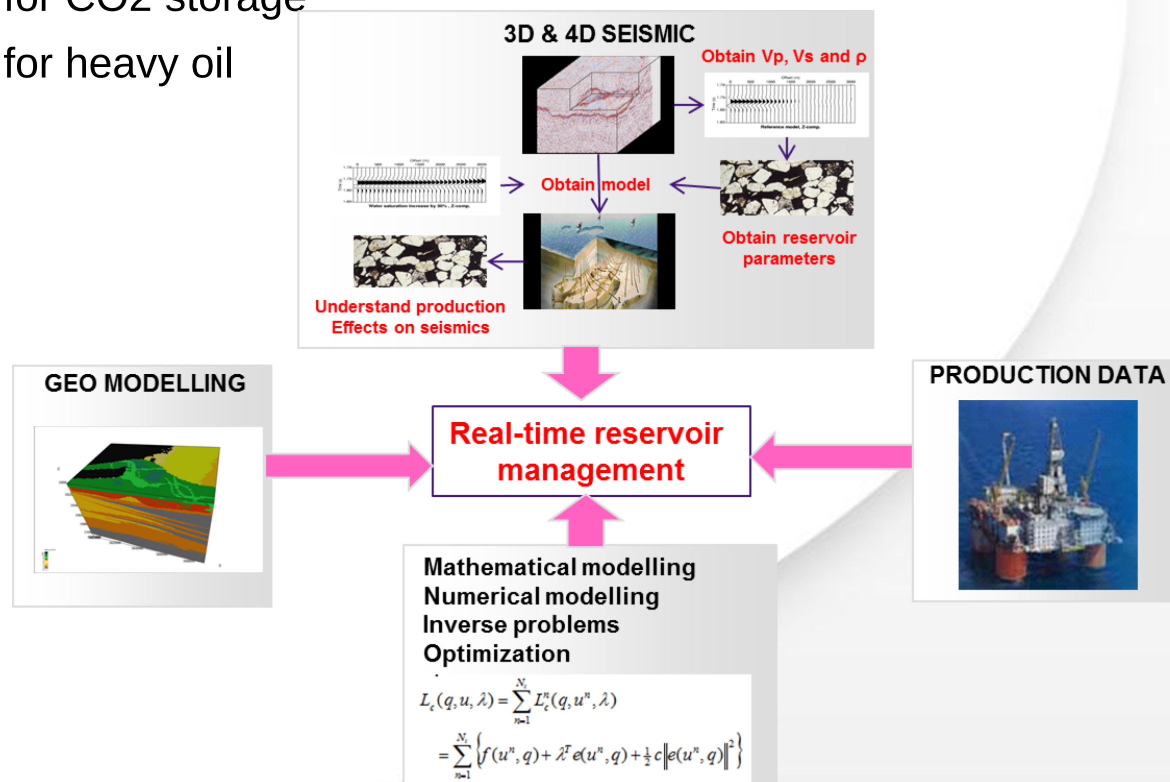
- WAG
- Foam
- Low salinity surfactant
- Microbial IOR
- Nanoparticle polymers
- Low salinity polymers

- Combined low salinity and surfactant flooding
- CIPR has developed the first pore scale network models for EOR processes



Monitoring

- Dynamic reservoir characterization and monitoring
  - Rock physics and seismic reservoir characterization
  - Continuous model updating with production data and 4D seismics
  - Multiscale and level set methods for history matching
  - Inversion of electromagnetic data
  - Joint inversion of seismic, EM and Production data
  - Monitoring and inversion for CO2 storage
  - Monitoring and inversion for heavy oil



Student programmes

Since 2003 CIPR has produced
164 Masters 83 PhDs in geology,
geophysics, chemistry and mathematics

- Cooperation with University of Bergen on Master and PhD programme
- Currently 30 PhD student and 40 master students at CIPR
- Very broad international profile
- 200 + requests annually for PhD positions
- Student exchange with Universities in the US, France, Italy, Germany and Oman
- All students are attached to ongoing projects
- Joint, commonly cross-disciplinary supervision

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Benefits of increased industry contact

- CIPRs domain is applied research
- Contact with the industry
    - Helps CIPR to further direct and focus research efforts towards the industry's needs
    - Keeps CIPR *au courant* with industry practice
    - Enables CIPR to communicate relevant academic research to industrial partners
    - Facilitates practical implementation of research results

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Thank you for your attention!

For further information see poster session or visit our website www.cipr.uni.no

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