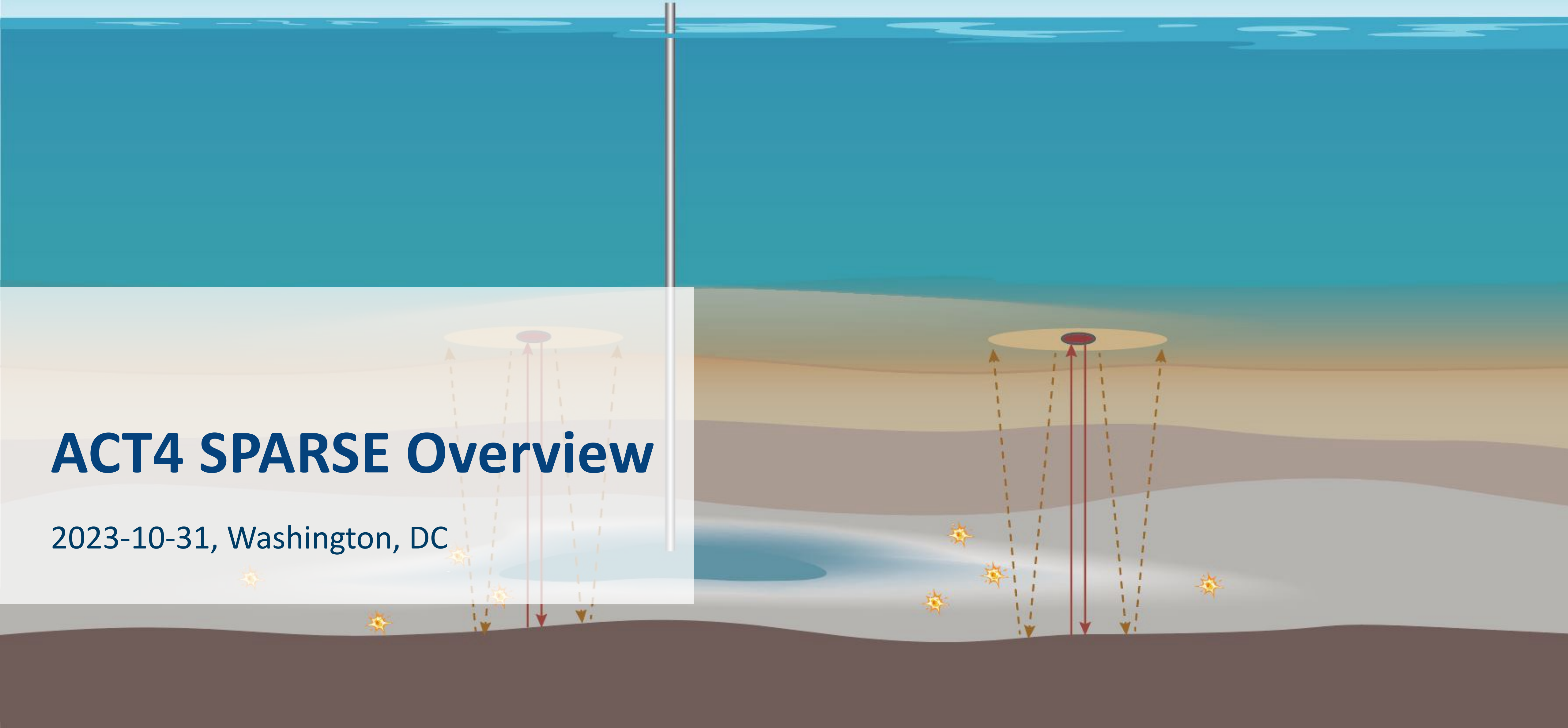
SPARSE



ACT4 SPARSE Overview

2023-10-31, Washington, DC

SINTEF

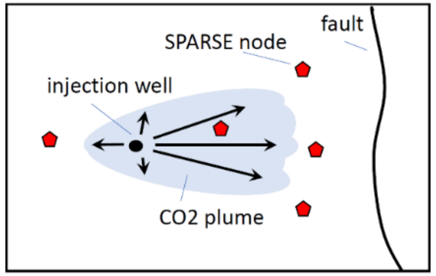
ACT4 SPARSE:

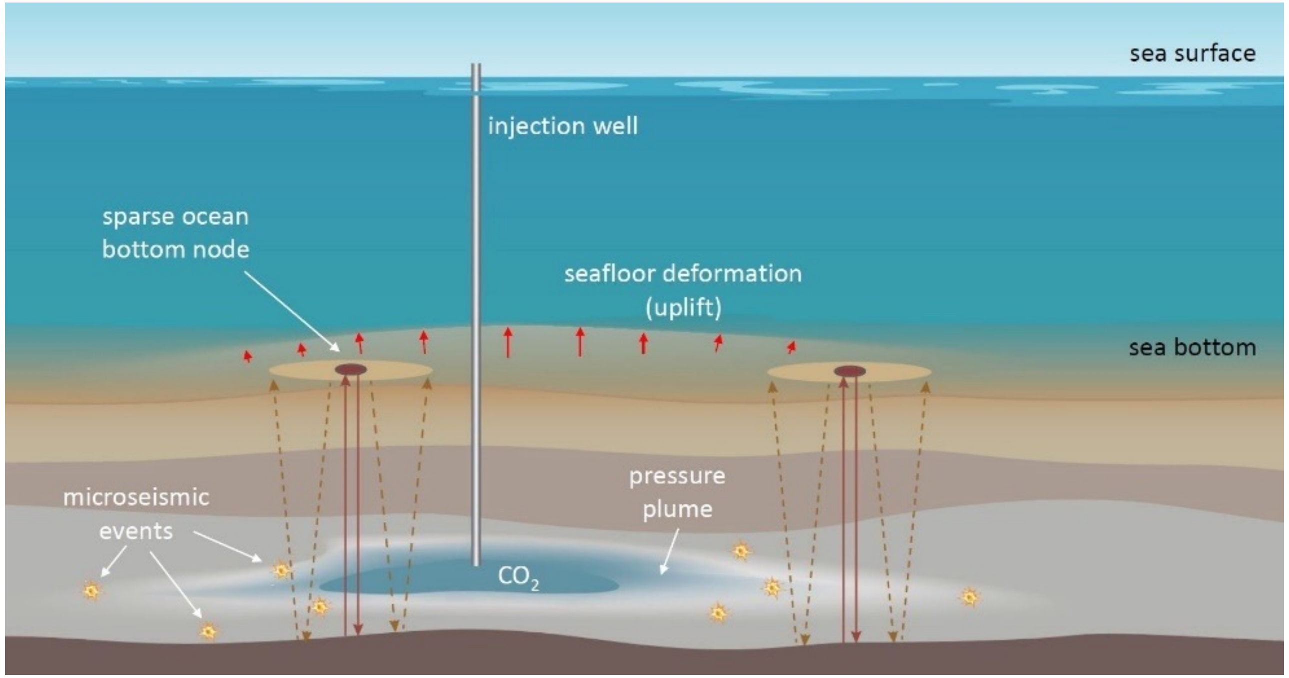
Seafloor Passive-Active Reservoir monitoring using Seismic, Electromagnetics, gravity, and surface deformation

SPARSE

SINTEF, BERKELEY LAB, CMC RESEARCH INSTITUTES, UNIVERSITY OF CALGARY, QUAD GEOMETRICS, SpotLight, PRECISIONIMPULSE, GeoSoftware™, Qeye, 3P, Accelerating CCS Technologies, Horisont energi, NEPTUNE ENERGY

- Enable low-cost long-term monitoring & facilitate GT storage
- SPARSE background monitoring
    - Node-based conformance and containment monitoring
        - Sparse data, sparse nodes
        - May trigger target-oriented active surveys when needed
        - Reduce / remove need for conventional active surveys
- Main requirements:
    - Extract sufficient information from sparse data for detection and quantification
        - Track pressure, saturation, stress and strain changes
    - High repeatability
    - Low-cost installation, operation, maintenance over decades
        - Solutions must be practical





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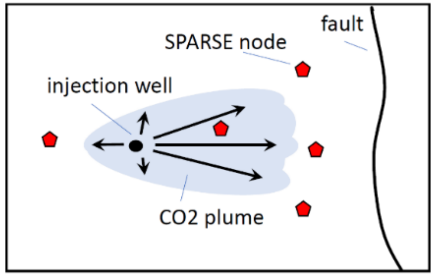
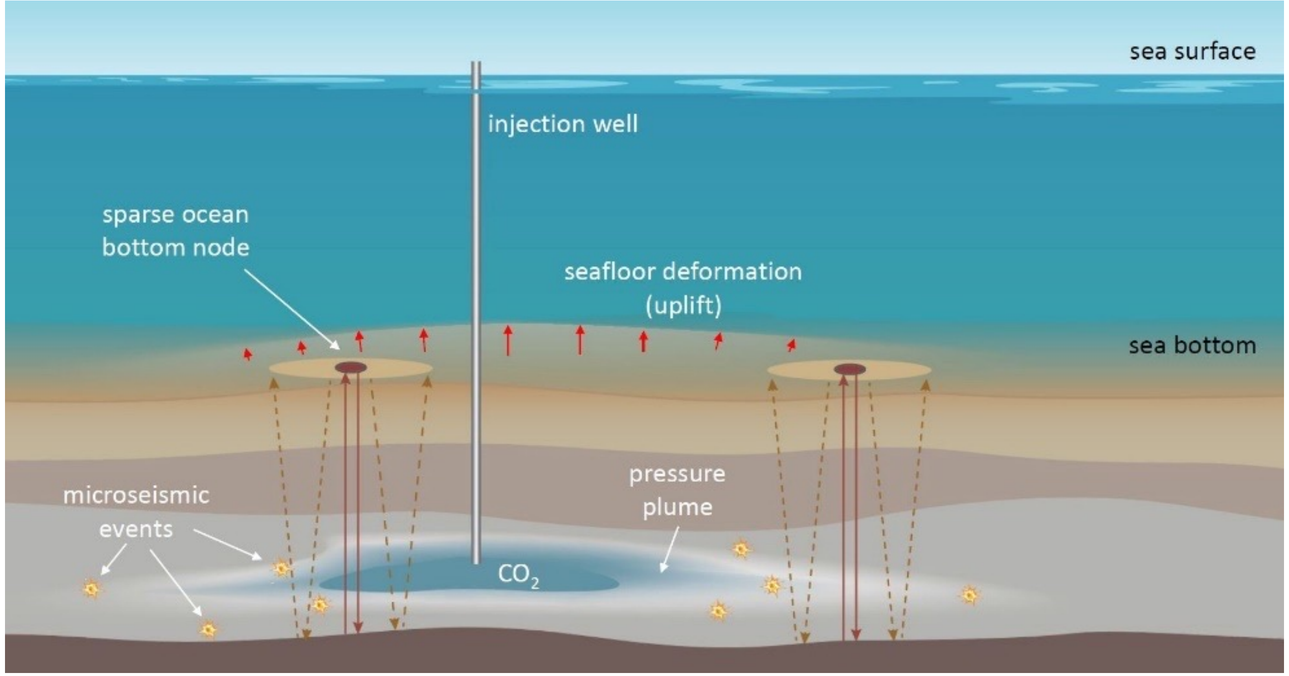
- Key targets:
  - Establish principal node design
  - Quantify key parameters and automatically assess conformance from sparse data
  - Determine technical requirements for implementation of sparse nodes
  - Assess performance of sparse monitoring at CaMI.FRS test site.
  - Test sparse monitoring concept using models / data from large-scale storage projects.

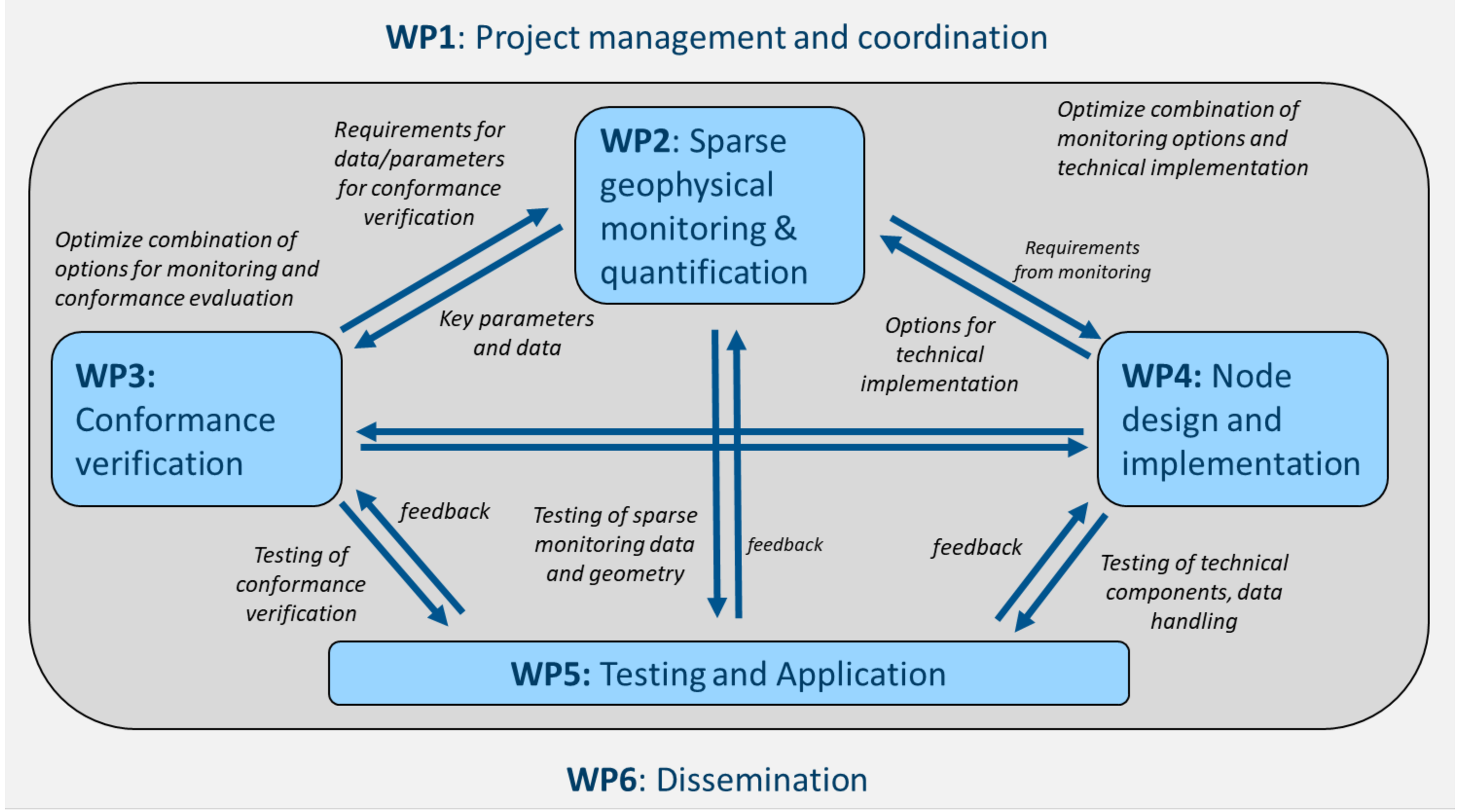


- Expected outcomes:
  - Geophysical toolbox for SPARSE multi-physics monitoring
  - Conformance toolbox
  - Recommendations for technical design and implementation
  - Workflow for designing optimum sparse monitoring system
  - Design of SPARSE monitoring system for e.g., a NCS CCS license

Requires full integration and optimization of all components during the design process!



SPARSE work plan and partners



Organization	Country
SINTEF (coordinator)	**Norway**
Horizont Energi (HE)	Norway
Neptune Energy (NE)	Norway
Quad Geometrics (QUAD)	Norway
Lawrence Berkeley National Lab (LBNL)	**United States**
Chevron	United States
Carbon Management Canada (CMC)	**Canada**
3P Technlogy Corp (3PTC)	Canada
University of Calgary (UofC)	**Canada**
Q-Eye Labs (QEL)	Canada
GeoSoftware	Canada
Spotlight (Spot)	France
Precision Impulse (Prec)	UK

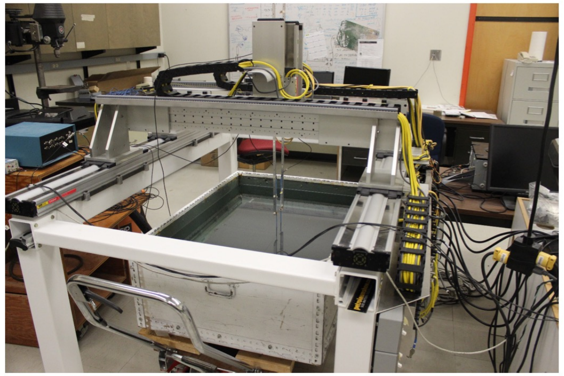
WP2: Sparse Geophysical Monitoring and Quantification (lead: UofC/CREWES)

UNIVERSITY OF CALGARY

Objectives:

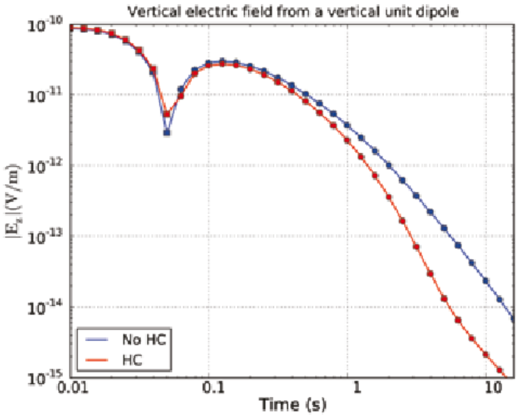
Optimize and further develop geophysical monitoring for sparse long-term and low-cost CO_2 monitoring, including

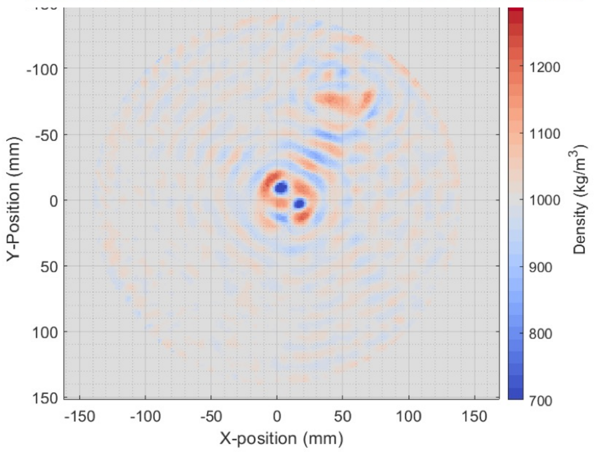
- Active and passive geophysical monitoring for reliable 4D sparse monitoring .
- Extraction and optimum use of information from sparse data
- Quantification of relevant parameters for conformance and containment monitoring



Task 2.1 Sparse Geophysical Monitoring

- Investigate / simulate sparse active and passive seismic, CSEM, gravity, and deformation data for monitoring





Task 2.2 Data Exploitation

- Determine how to extract maximum amount of information from seismic and other data types
- Investigate different source/receiver configurations

Task 3.3 Quantification

- Quantify parameters of interest (pressure, saturation, etc) using
  - Joint inversion
  - Rock physics inversion
  - Machine learning based imaging

Partners involved: SINTEF,CMC, LBNL, QUAD, Spot

WP3: Conformance Verification (lead: SINTEF)

SINTEF

Objectives:

Automatic conformance verification, based on the comparison between modelled behaviour and observed data including

- Reservoir and geomechanical modelling.
- Automatic evaluation of conformance
- Test with existing reservoir models and data (e.g., CaMI.FRS)

Task 3.1 Reservoir Modelling

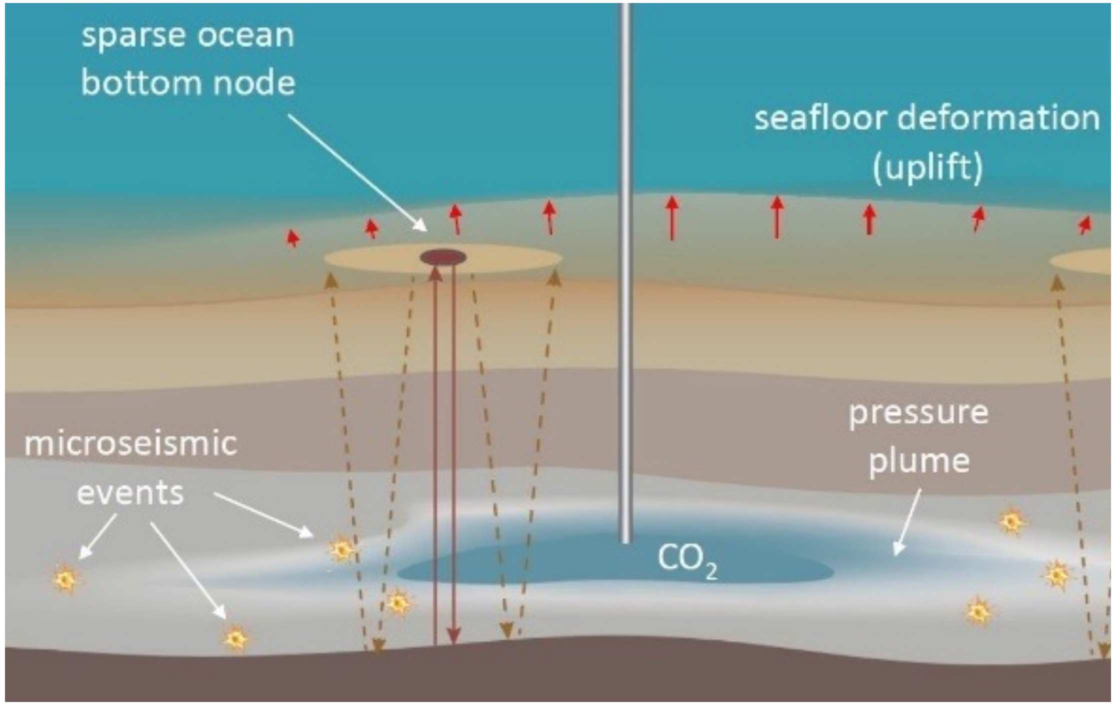
- Predict pressure and saturation in the reservoir

Task 3.2 Geomechanical Modelling

- Perform geomechanical modelling to predict stress and strain
    - Input: mechanical properties, known faults, and uncertainties
- Compare predicted and observed behaviour
    - E.g., surface deformation, 4D seismic, and statistical occurrence of microseismic events.

Task 3.3 Conformance evaluation

- Automatic evaluation of conformance
- Based on Tasks 3.1, 3.2 (modelling)
- Links to Task 2.3 and Task 4.3



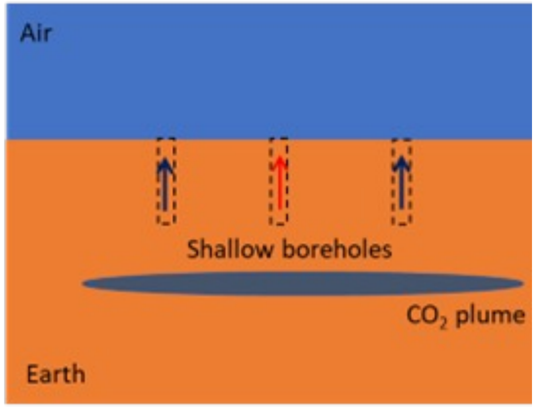
Partners involved: CMC, UofC, HE

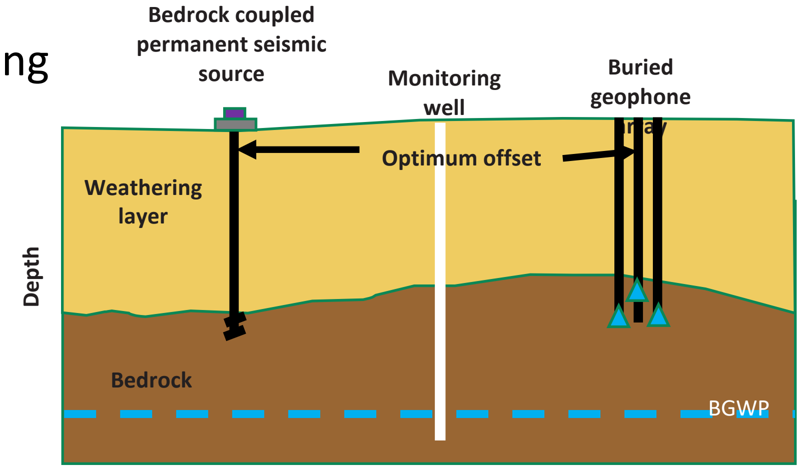
WP4: Node design and implementation (lead: LBNL)

BERKELEY LAB

Objectives: Determine the optimum implementation of SPARSE monitoring, including

- Node design, positioning, cost
- Technical implementation
- Automatic data processing, reduction, and evaluation



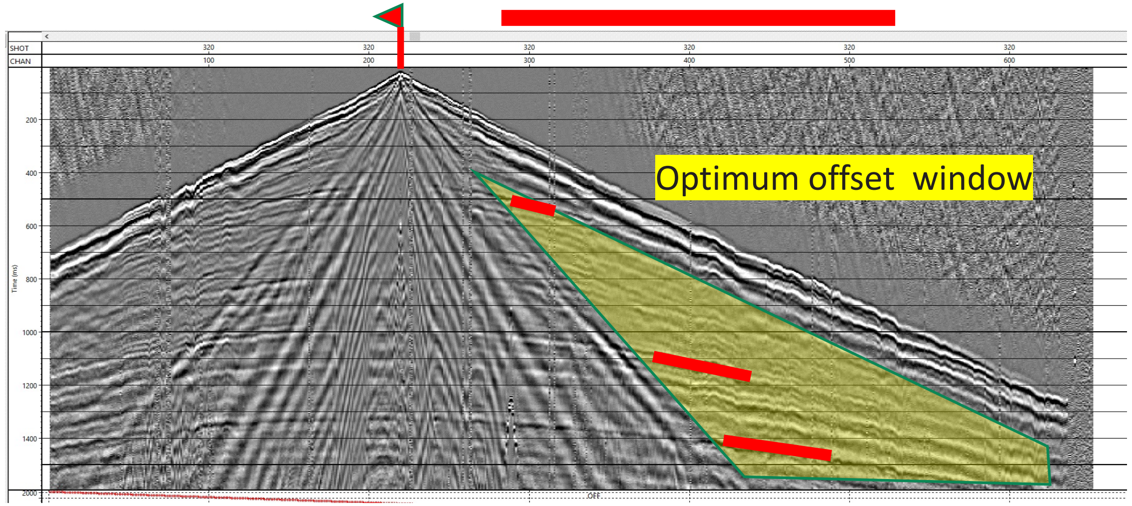


Task 4.1 Optimum Design

- Determine optimal construction of nodes
- Determine optimal positioning
- Analyze value of inorfmation given node costs

Task 4.2 Technical Realization

- Deploy and test vertical source CSEM system using shallow wells at CaMI.FRS and Svelvik Co2 Field Lab
- Test different permanent seismic sources
- Verify systems are working properly



Task 4.3 Automatic Data Processing, Reduction, and Evaluation

- Collect 'baseline' data sets
- Evaluate possibility of automation of processing and evaluation

Partners involved: SINTEF, CMC, UofC, QUAD

WP5: Application and Testing (lead: CMC)

Objectives: Test components of SPARSE monitoring, including

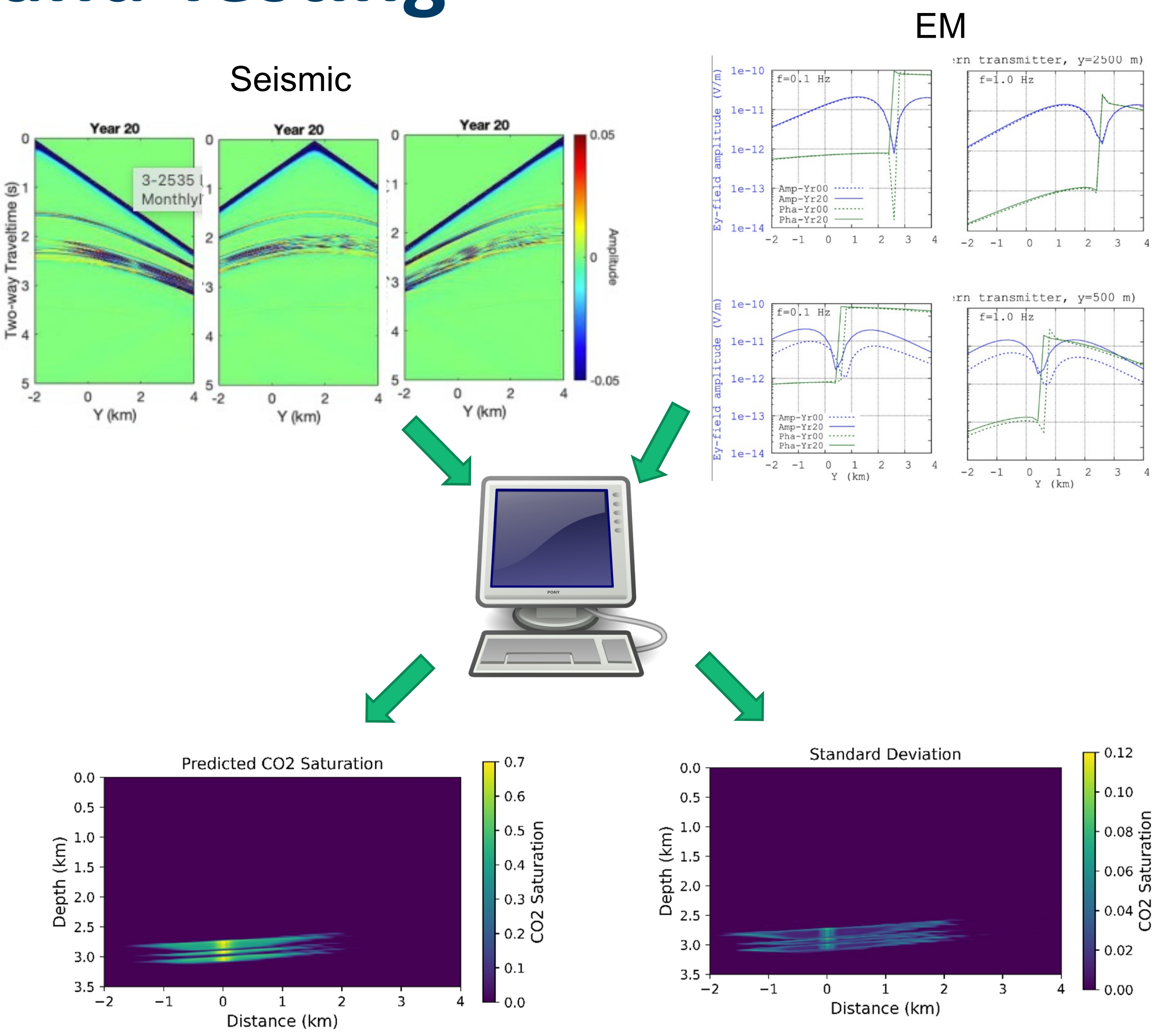
- Finalize design and installation of nodes
- Evaluate ability of sparse nodes to demonstrate conformance and containment
- Automatic data processing, reduction, and evaluation

Task 5.1 Testing at CaMI .FRS and Svelvik

- Test acquisition and processing of different geophysical components at two test sites
- Apply Machine learning and traditional joint inversions to data

Task 5.2 Technical Realization

- Analyze automatic management, and distribution
- Analyze imaing results for time lapse CO2 conformance



Partners involved: SINTEF, CMC, UofC, LBNL, Prec

SINTEF

Project Structure
- Time schedule

- Timing of the Project
  - 1 April 2023 – 31 March 2026 according to original plan (and contract with RCN)
  - Contract signed 16 June
  - Work at LBNL started in September

			year 1				year 2				year 3			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
WP1			D1.1	D1.2		D1.3		D1.4/M1.1		D1.5		D1.6		D1.7
WP2				D2.2		D2.3		D2.4		D2.5		D2.6		D2.7/D2.10
	WP2.1	sparse geophysical monitoring	M2.1/D2.1							D2.8				
	WP2.2	data exploitation												
	WP2.3	quantification					M2.2					D2.9		
WP3														D3.3
	WP3.1	Reservoir modelling	M3.1			D3.1								
	WP3.2	Geomechanical modelling		M3.2										
	WP3.3	Conformance evaluation				M3.3						D3.2		
WP4														D4.5
	WP4.1	Optimum design		M4.1/D4.1		M4.2/D4.2			M4.3/D4.3			M4.4/D4.4		
	WP4.2	Technical realization												
	WP4.3	Autom. data proc., reduc. and eval.												
WP5								D5.4		D5.5		D5.6		D5.7
	WP5.1	Testing at Field Labs				M5.1/D5.2		M5.2/D5.1		M5.3			M5.5	M5.4/D5.3/ D5.8
	WP5.2	Application to available real data				M5.6						D5.9		
	WP5.3	Design of system for NCS/ Errai												D5.10
WP6			M6.1/D6.1/ D6.2	D6.3	D6.4	D6.5	D6.6	D6,7	D6.8	M6.2/D6.9	D6.10	D6.11	D6.12	M6.3/M6.4/ D6.13

Dissemination & communication

- Questions?