



Deploying Cuttlefish Carbon Guard CCG: A Passive/Microseismic Technology to Monitor Subsurface Reservoir During CO₂ Injection.

Onshore Case Study and Adaptation for Offshore
Deployment

Dr Roy Bitrus, TenzorGEO Ltd,

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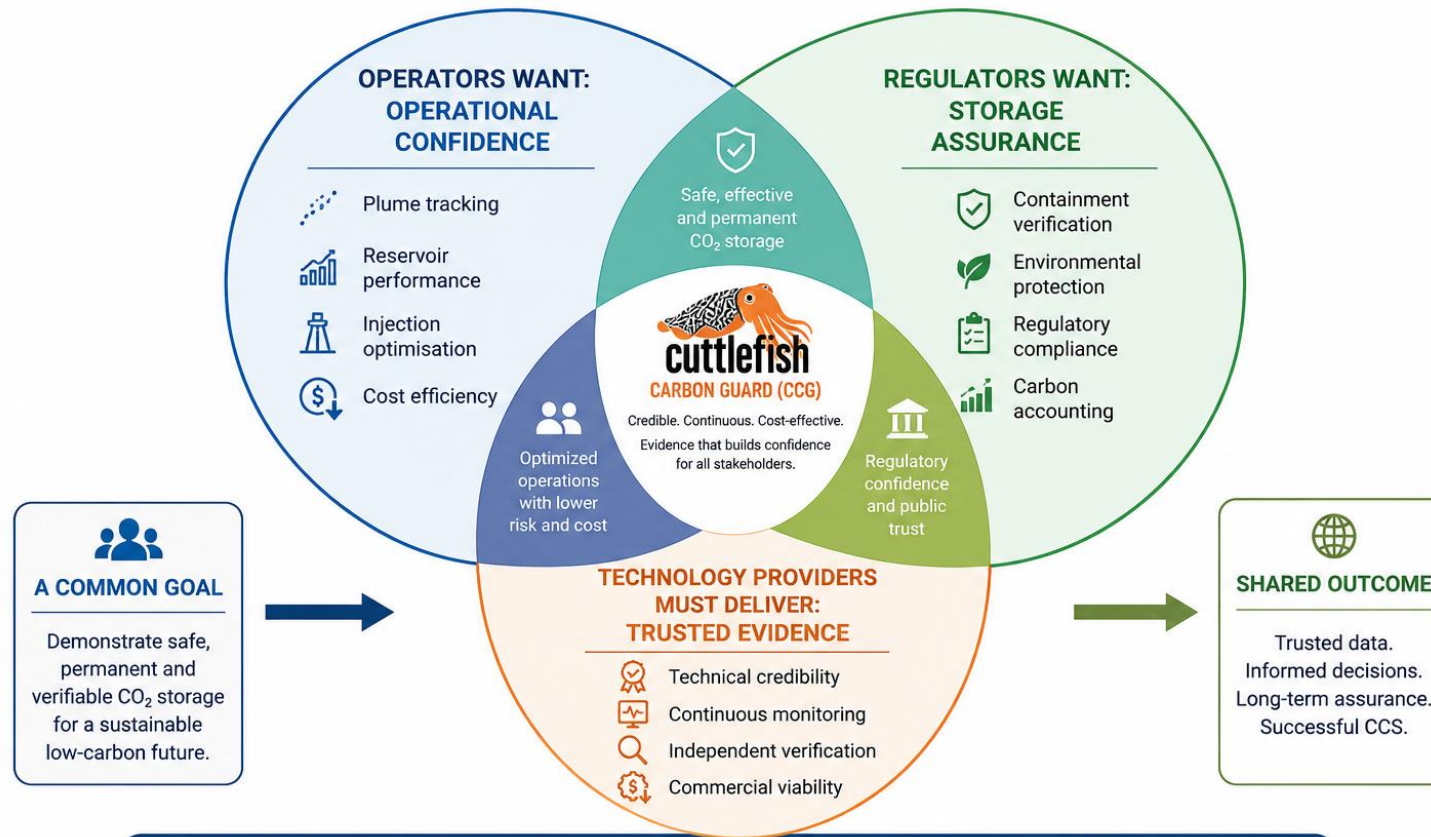


1. The CCS Challenge

The CCS Monitoring Challenge: Aligning Operators, Regulators and Technology Providers

THE MMV TRIANGLE

Aligning Operators, Regulators and Technology Providers for Successful CCS



CCG (LFS + FWL) bridges the needs of Operators and Regulators with credible technology that delivers trusted, cost-effective monitoring across the entire CCS lifecycle.

The Regulator's Challenge

Objective: Protect the environment, public safety and long-term storage integrity.

Key Question:

"Can the operator demonstrate, with credible evidence, that the CO₂ will remain safely stored for decades to centuries?"

The Operator's Challenge

Objective: Maximise storage performance while minimising cost and risk.

Key Question:

"Can I safely store more CO₂ while reducing operational uncertainty and monitoring costs?"

The Technology Provider's Challenge

Objective: Deliver trusted, technically credible and economically viable monitoring solutions.

Key Question:

"How do we provide credible, scientifically defensible evidence of storage integrity at a cost that operators can justify and regulators can trust?"

The future success of CCS depends on aligning three critical needs: operators require operational confidence, regulators require storage assurance, **and technology providers must bridge both** through credible, cost-effective MMV solutions.

1. The CCS Challenge – Our Solution

The Cuttlefish Carbon Guard (CCG) Technology Description



What is Cuttlefish Carbon Guard ?

- ✓ Cuttlefish Carbon Guard (CCG) is an innovative passive seismic monitoring technology designed for both onshore and offshore applications.
- ✓ CCG delivers comprehensive subsurface insights across a broad frequency range (0.1 Hz to >100 Hz).



Value

- ✓ Detect the fluid front movement of injected CO2
- ✓ Detect induced microseismicity during CO2 injection
- ✓ Delineate hydrocarbon deposits/injected CO2
- ✓ Monitor the integrity of the reservoir caprock
- ✓ Environmentally friendly



Trial Project Area

- ✓ UAE



Low Frequency Seismic Technology (LFS) 0.1 – 5Hz

- LFS to monitor and visualize CO2 rock saturation velocity changes.
- LFS to monitor the spatial distribution of CO2 in the reservoir to ensure CO2 is contained within the defined storage boundaries

Full Wave Location Technology (FWL) 5hz - >100 Hz

- Monitor and detect induced microseismic activity.
- Using the full wave information from seismic trace rather than to use travel time information only.
- Better understanding of the CO2 injection impact on the reservoir





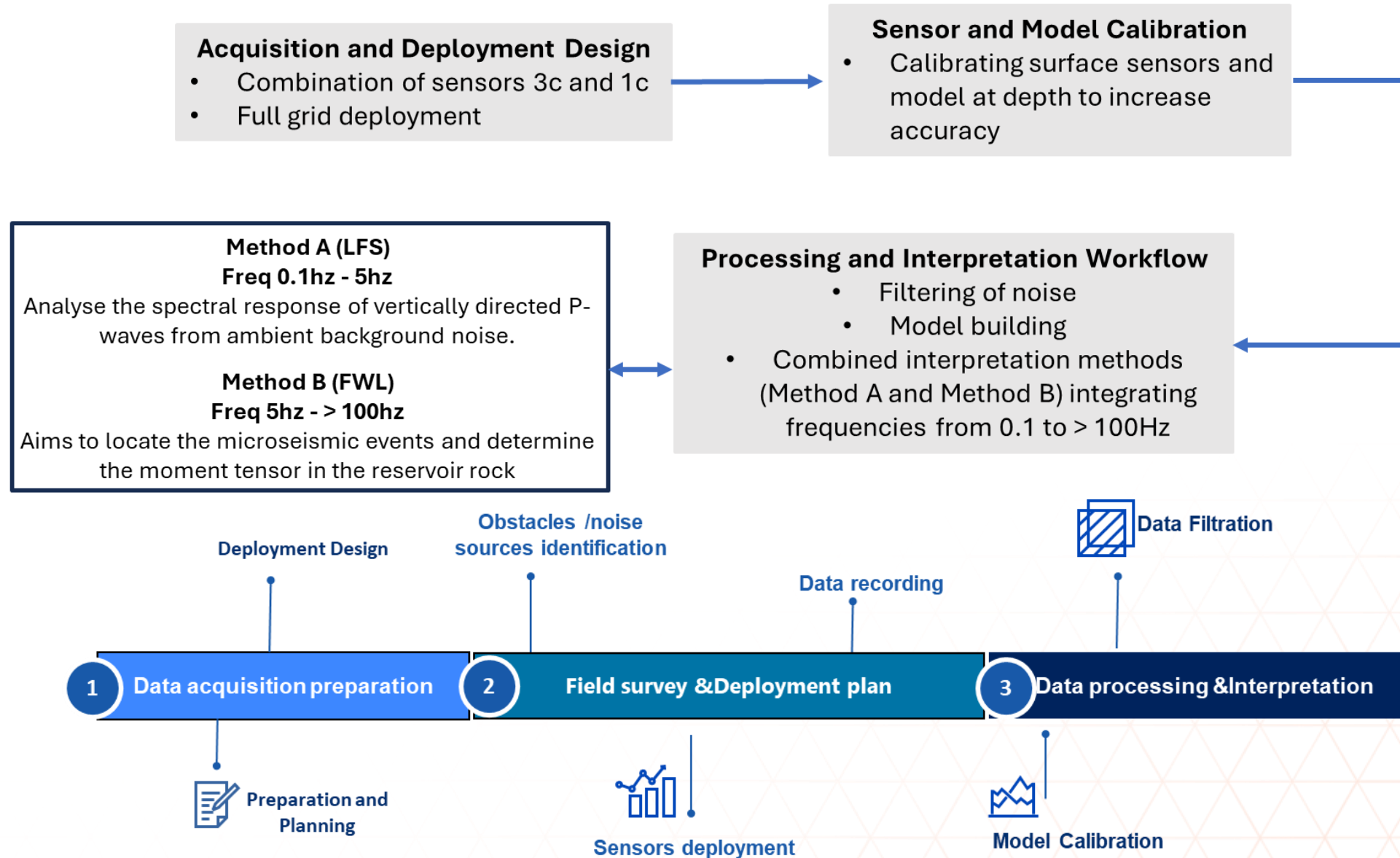
ONSHORE CASE STUDY

**Cuttlefish Carbon Guard (CCG) Subsurface MMV
Technology Deployed in the UAE to Monitor CO₂-EOR**



2. Onshore Case Study - CO₂ EOR Storage Monitoring

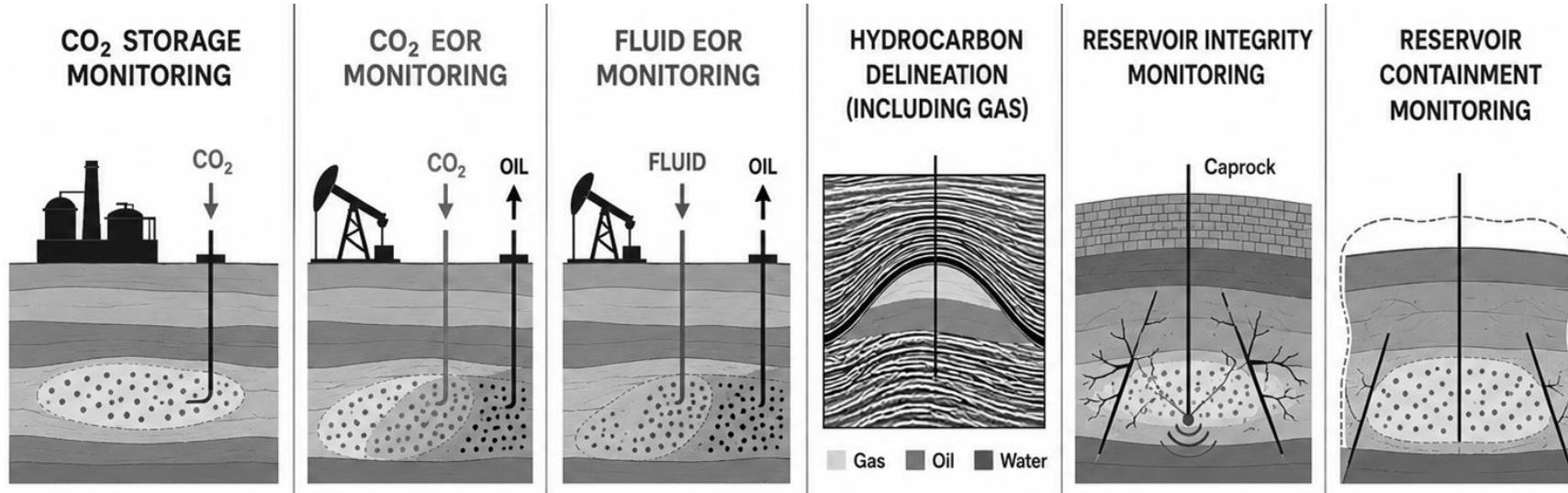
CCG Method Workflow for Deploying Onshore



3. Application and Strategic Value for Deploying CCG - Onshore

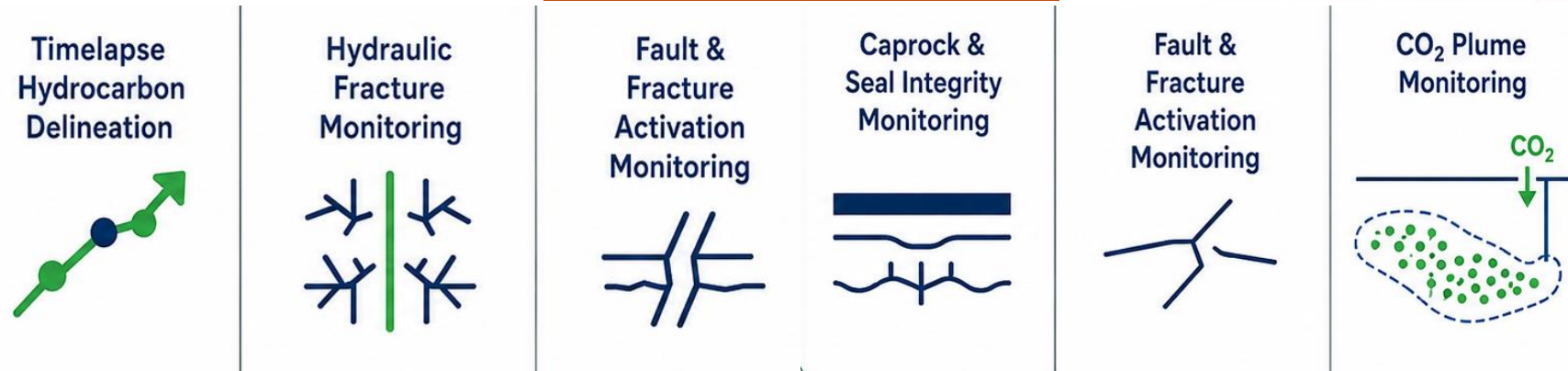
CCG Technology Application and Monitoring Capability

Applications



In Mature fields experiencing pressure decline, decreased production, and water breakthrough, CCG offers a powerful, non-intrusive tool that can be integrated with other Reservoir Monitoring Technologies i.e downhole monitoring tools.

Monitoring Capabilities



4. Onshore Case Study - CO₂ Storage Monitoring

CCG Method Workflow for Deploying Onshore – Sensor Deployment



Temporal Monitoring Sensors

30 – 50 days continuous recording battery life
INOVA QUANTUM Sensors and
SmartSolo IGU-16HR 3C



Permanent Monitoring Sensors

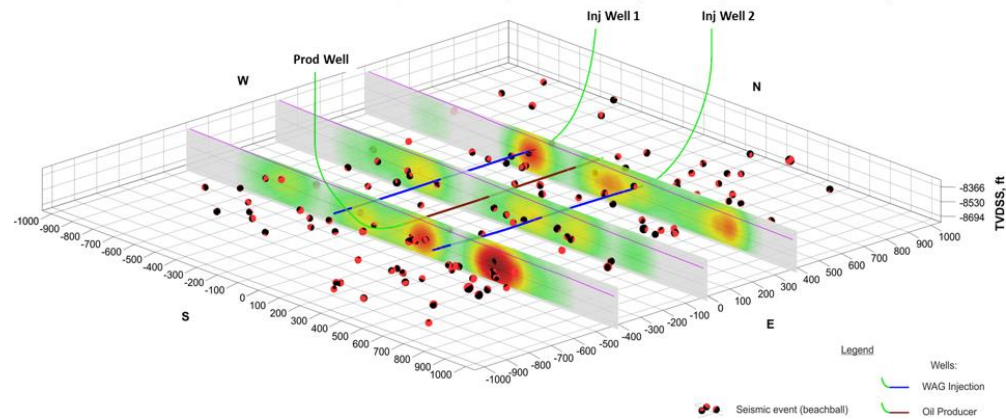
SoloNet-3C BH Monitor
Real-time borehole Seismic Monitoring
System



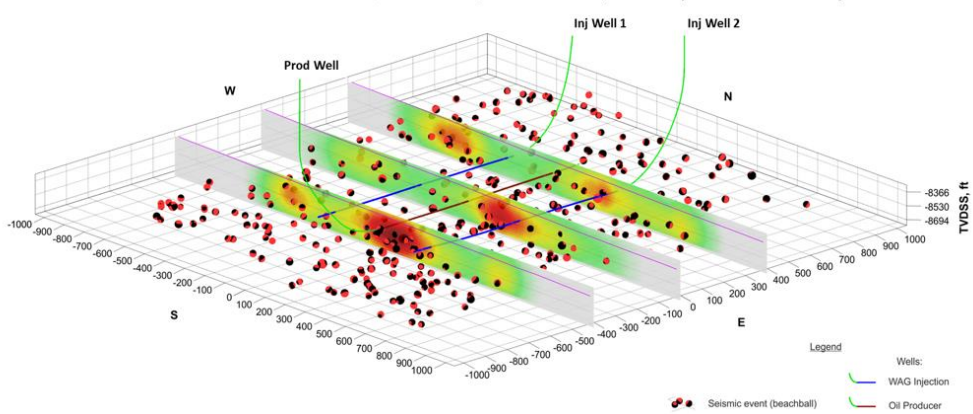
4. Onshore Case Study - CO₂ Storage Monitoring

CCG Method Workflow for Deploying Onshore - Results

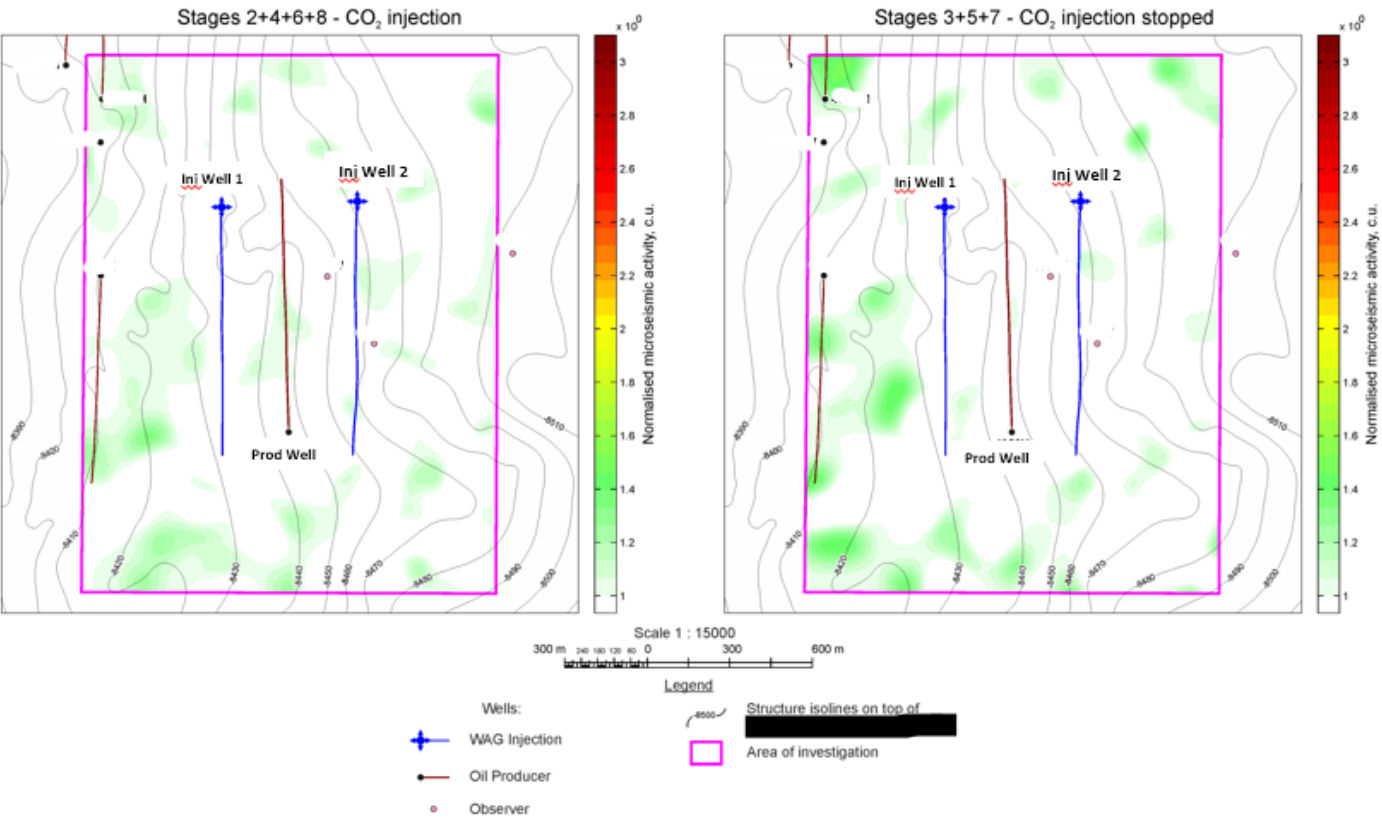
Reservoir Formation, After Stage 2 – CO₂ Injection (10 – 12.07.2023)



Reservoir Formation, After Stage 8 – CO₂ Injection (22 – 26.07.2023)

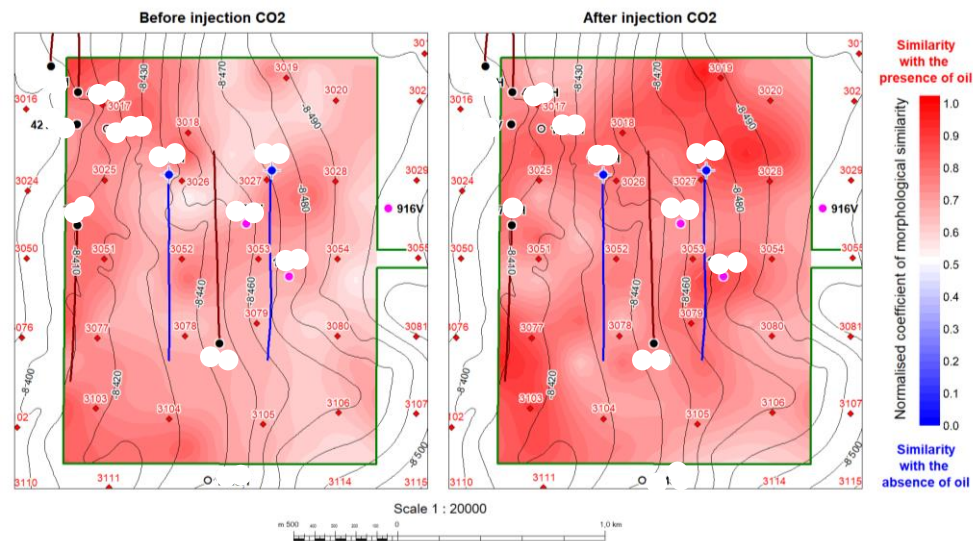


Reservoir Caprock – Normalised Map

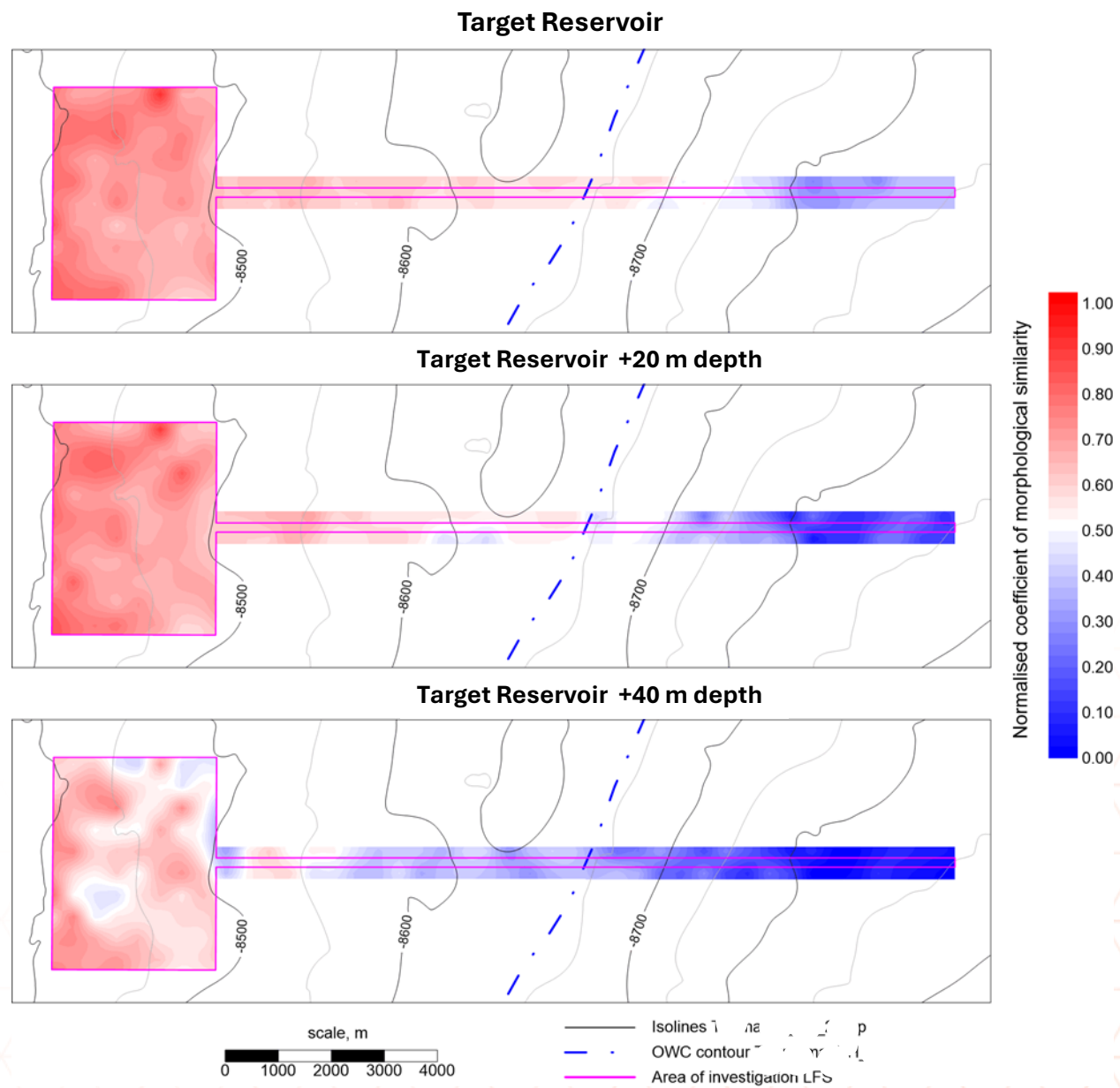
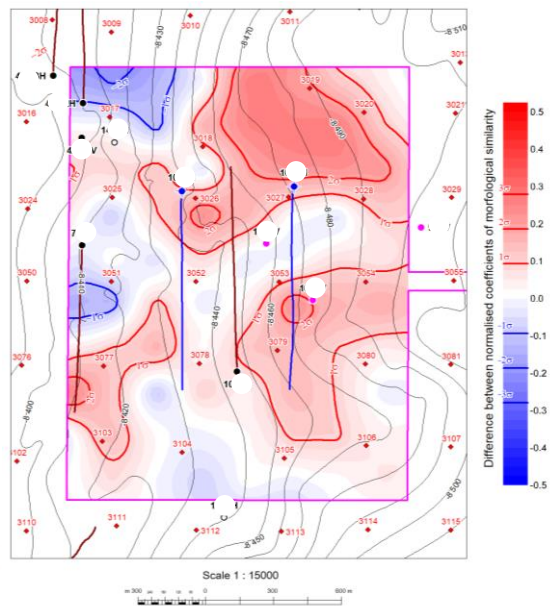


4. Onshore Case Study - CO₂ Storage Monitoring

CCG Method Workflow for Deploying Onshore - Results



Difference Map

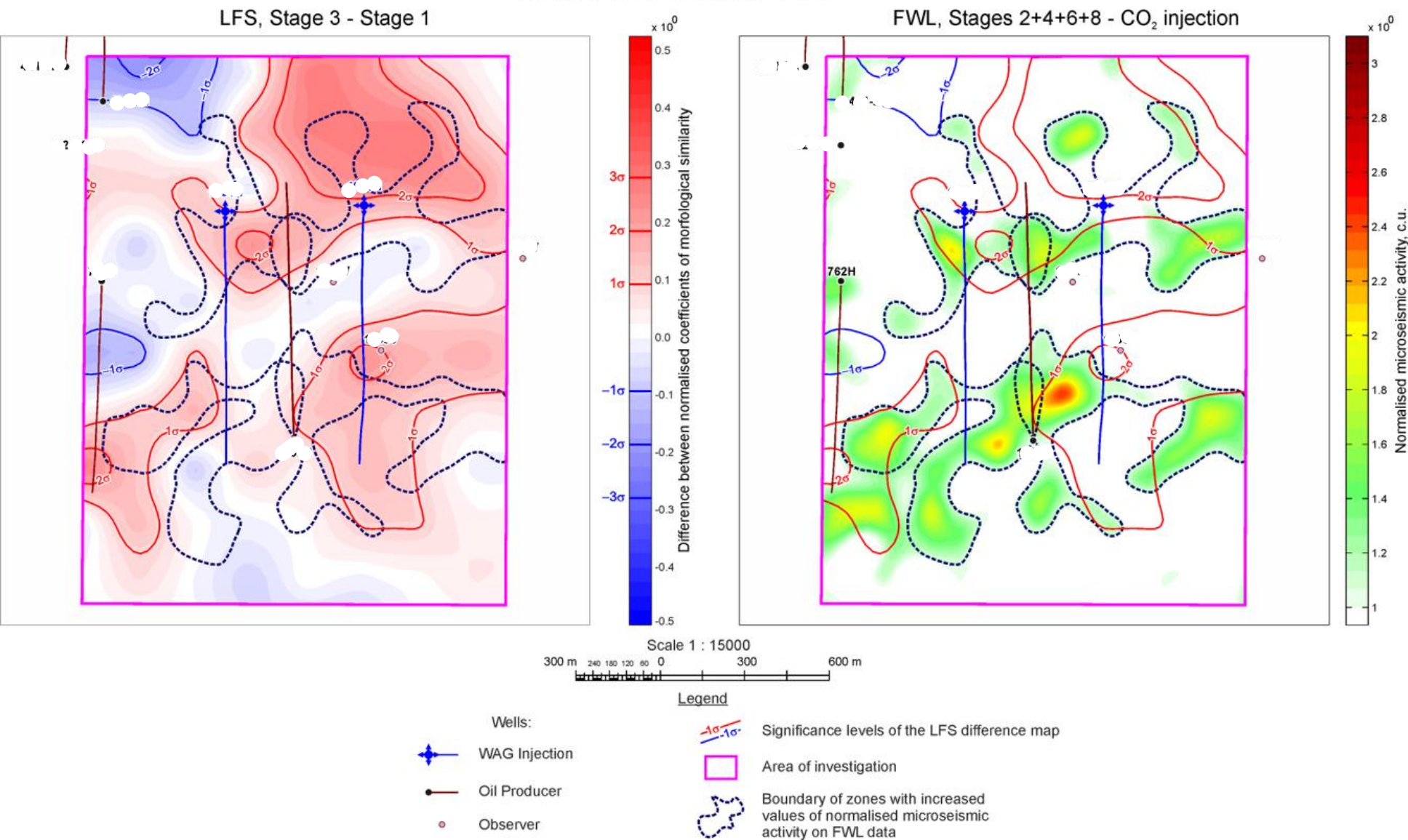


4. Onshore Case Study - CO₂ Storage Monitoring

CCG Method Workflow for Deploying Onshore - Results



Reservoir Formation



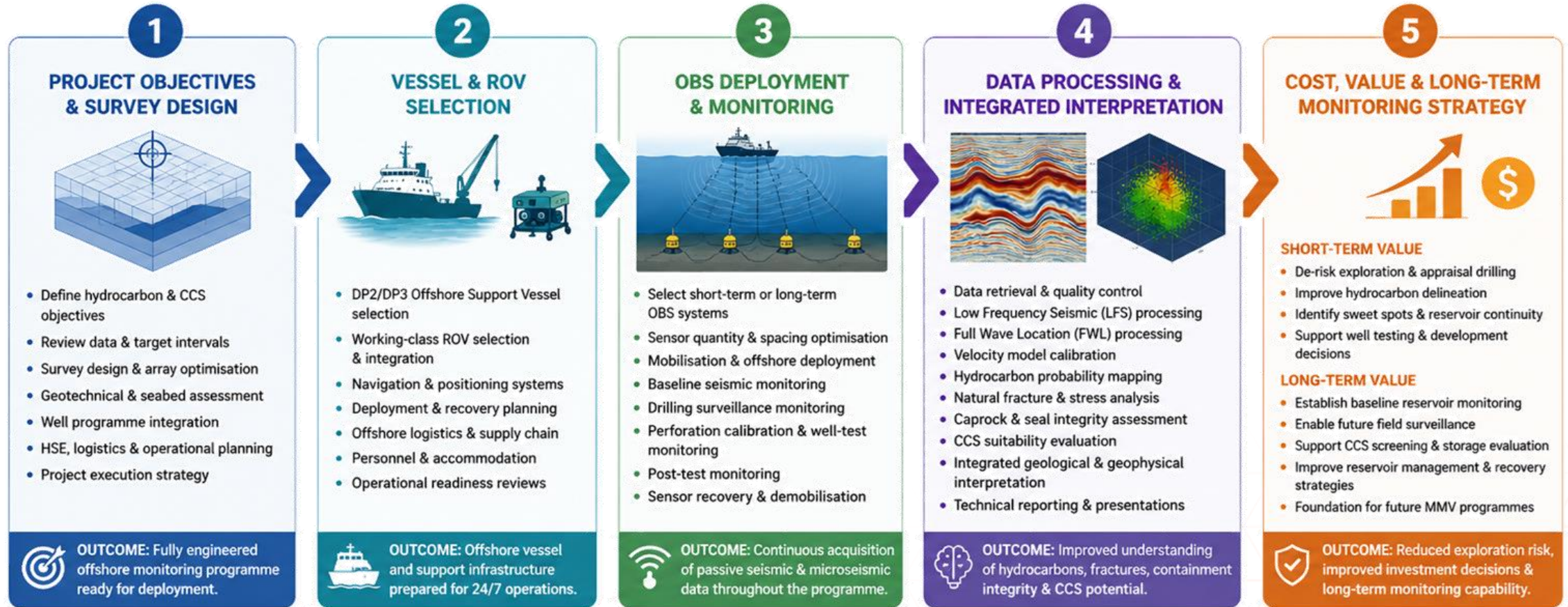


OFFSHORE APPLICATION

**Cuttlefish Carbon Guard - Offshore (CCG - Offshore)
Subsurface MMV Technology and Offshore
Deployment**

5. CCG-OFFSHORE DEPLOYMENT WORKFLOW

Project Objectives & Survey Design → Vessel & ROV Selection → OBS Deployment & Monitoring → Data Processing & Interpretation → Cost, Value & Long-Term Monitoring Strategy



OBS Sensors or OBN Nodes



6. THE VALUE OF CCG-OFFSHORE

Passive Seismic & Microseismic Monitoring for CO₂ Offshore Projects

Tensor **GEO**
CCG-OFFSHORE

DE-RISKING CO₂ STORAGE. ENHANCING CONFIDENCE. DELIVERING LONG-TERM VALUE.

1. RESERVOIR CHARACTERISATION & SITE SELECTION



- Delineates reservoir extent and fluid distribution
- Identifies high-quality storage intervals and sweet spots
- Improves understanding of reservoir continuity
- Supports screening and ranking of CO₂ storage sites

2. CO₂ PLUME MONITORING & TRACKING



- Monitors CO₂ movement and distribution
- Tracks plume migration pathways over time
- Identifies preferential flow and storage zones
- Optimises injection strategies and storage efficiency

3. CAPROCK & CONTAINMENT INTEGRITY MONITORING



- Assesses caprock and seal integrity
- Detects leakage pathways, faults and fracture activation
- Monitors containment performance throughout injection
- Provides early warning of geomechanical changes

7. ENVIRONMENTAL & OPERATIONAL BENEFITS

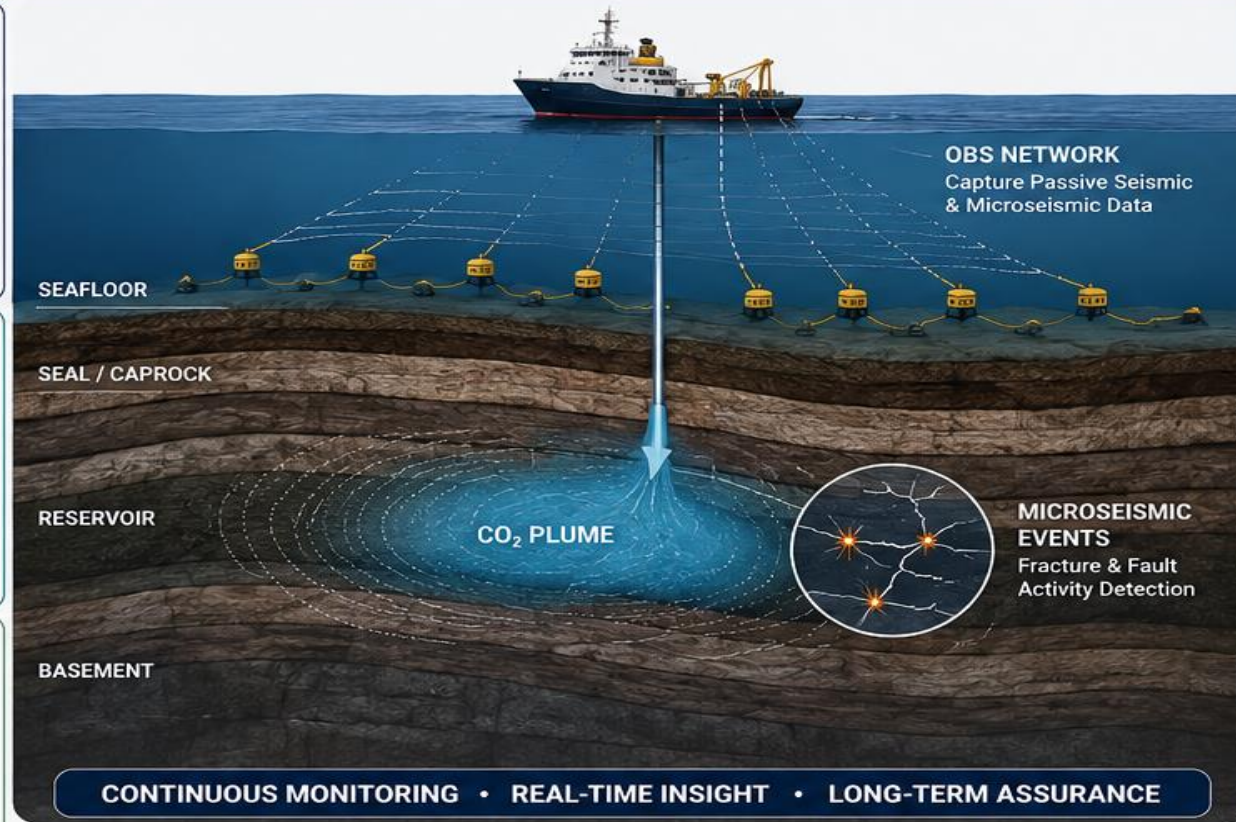


- Passive system – no airguns or active seismic sources
- Low environmental footprint
- Minimal impact on marine environment
- Suitable for continuous long-term offshore monitoring
- Integrates with existing well, seismic and reservoir datasets

8. LONG-TERM STRATEGIC VALUE



- Establishes a permanent reservoir monitoring framework
- Supports future expansion of CO₂ storage operations
- Enables digital reservoir and storage management models
- Foundation for long-term MMV programmes and carbon storage assurance



4. MICROSEISMIC & GEOMECHANICAL MONITORING



- Detects and locates microseismic events in real time
- Maps natural fractures and fault networks
- Evaluates stress redistribution in reservoir and overburden
- Improves understanding of reservoir response to injection

5. MONITORING, MEASUREMENT & VERIFICATION (MMV)



- Provides independent subsurface monitoring for CO₂ storage
- Supports regulatory compliance and reporting
- Generates baseline and time-lapse datasets
- Enhances stakeholder confidence in storage performance

6. RISK REDUCTION & OPERATIONAL ASSURANCE



- Reduces uncertainty and subsurface risk
- Supports informed operational and investment decisions
- Identifies risks before they impact operations
- Enhances confidence in long-term storage security and project economics

KEY OUTCOME



CCG-Offshore delivers a single integrated passive seismic and microseismic solution that images reservoir fluids, monitors CO₂ plume behaviour, assesses caprock integrity, detects microseismic activity, and supports long-term storage verification throughout the life of an offshore CCS project.



IMPROVED INVESTMENT
DECISIONS



REDUCED EXPLORATION
& STORAGE RISK



ENHANCED SAFETY
& ENVIRONMENTAL STEWARDSHIP



STAKEHOLDER CONFIDENCE
& REGULATORY TRUST



REAL-TIME INSIGHT.
LONG-TERM VALUE.



Appreciation



roy.bitrus@tenzorggeo.co.uk



+447854859911



www.tenzorggeo.co.uk

