ENOS Workshop
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ACT project "DETECT"

Marcella Dean
Verification Monitoring Program Unit Lead, Shell Global Solutions International BV

DETECT Project

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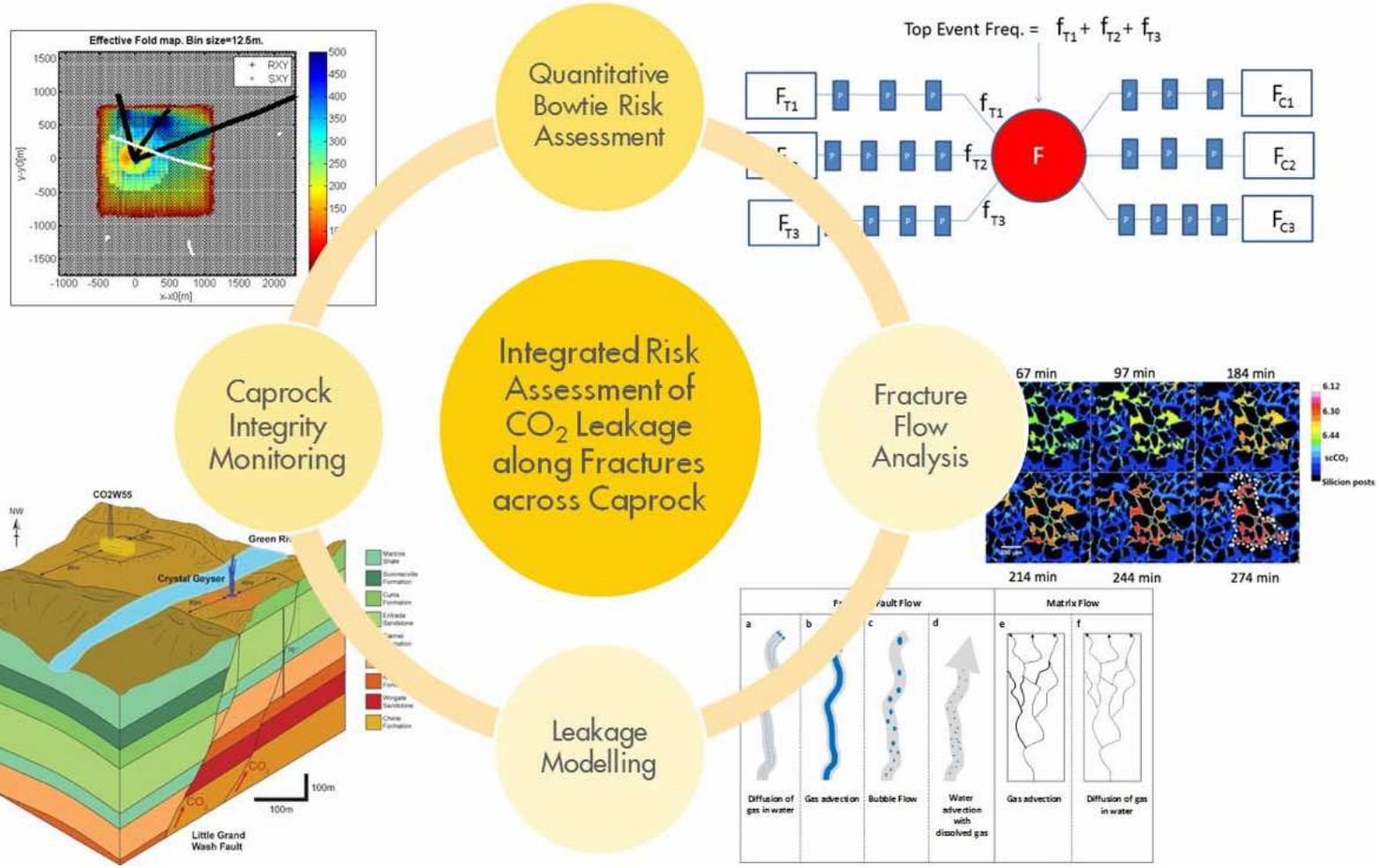
Overview, Objectives, Collaboration Partners, Key Targets, and Work Packages

DETECT Determining the risk of CO_2 leakage along fractures of the primary caprock using an integrated monitoring and hydro-mechanical-chemical approach

D E T E C T

INTEGRATED GEOLOGICAL CO_2 LEAKAGE RISK ASSESSMENT

Overview



The project has been subsidized through the ERANET Cofund ACT (Project no. 271497), the European Commission, the Research Council of Norway, the Rijksdienst voor Ondernemend Nederland, the Bundesministerium für Wirtschaft und Energie, and the Department for Business, Energy & Industrial Strategy, UK.

D E T E C T

INTEGRATED GEOLOGICAL CO_2 LEAKAGE RISK ASSESSMENT

DETECT Determining the risk of CO_2 leakage along fractures of the primary caprock using an integrated monitoring and hydro-mechanical-chemical approach

Objectives

- **Shell-led consortium will generate CCS industry leading guidance for managing geological CO_2 storage risks allowing stakeholders to:**
  - Perform effective caprock and seal integrity risk assessment
  - Communicate clearly and logically assessed caprock risks
  - Understand realistic leakage rates and related implications
  - Select realistic and efficient leakage rate modelling approaches
  - Select cost effective and innovative containment monitoring technologies

Collaboration

- **Focused consortium with recognized technology experts**
  - **Shell Global Solutions International BV (Shell)** (project lead, modelling, monitoring): Leveraging key experience from the Peterhead and Quest CCS projects
  - **Heriot-Watt** (modelling): Sebastian Geiger's group is widely recognised for modelling fractured media for hydrocarbon production and CO_2 storage
  - **RWTH Aachen University** (laboratory work): Has a world-class laboratory for petrophysical, geochemical and mineralogical testing of low permeability rocks
  - **Risktec Solutions** (SME subsurface risk assessment): Since early 1990s is at the forefront of using and developing the bowtie method for risk assessment

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DETECT Determining the risk of CO_2 leakage along fractures of the primary caprock using an integrated monitoring and hydro-mechanical-chemical approach

D E T E C T

INTEGRATED GEOLOGICAL CO_2 LEAKAGE RISK ASSESSMENT

Key Targets

- **Laboratory experiments**
  - **Determine** the impact of reservoir stress changes, chemical reactions and swelling clays on fracture flow properties
- **Field studies**
  - **Characterise** fault and fracture network geometries
- **Hydro-mechanical-chemical modelling**
  - **Determine** flow in a single fracture and connected matrix, potential for upscaling of flow in fault damage zones
  - **Perform** fault zone leak path modelling of storage complexes
- **Monitoring feasibility studies**
  - **Identify** monitoring technologies to detect leakage across caprock
  - **Determine** expected monitoring performance based on fracture flow rates modelled
- **Integrated qualitative and quantitative risk assessment**
  - **Determine** passive safeguards (from lab and modelling) and active safeguards (from monitoring) for bowties and risk models
  - **Generate** guidance bowties for efficient risk assessment
- **Dissemination**
  - **Ensure** long-term relevance of outputs

Monitoring well at the Quest CO_2 Storage site.

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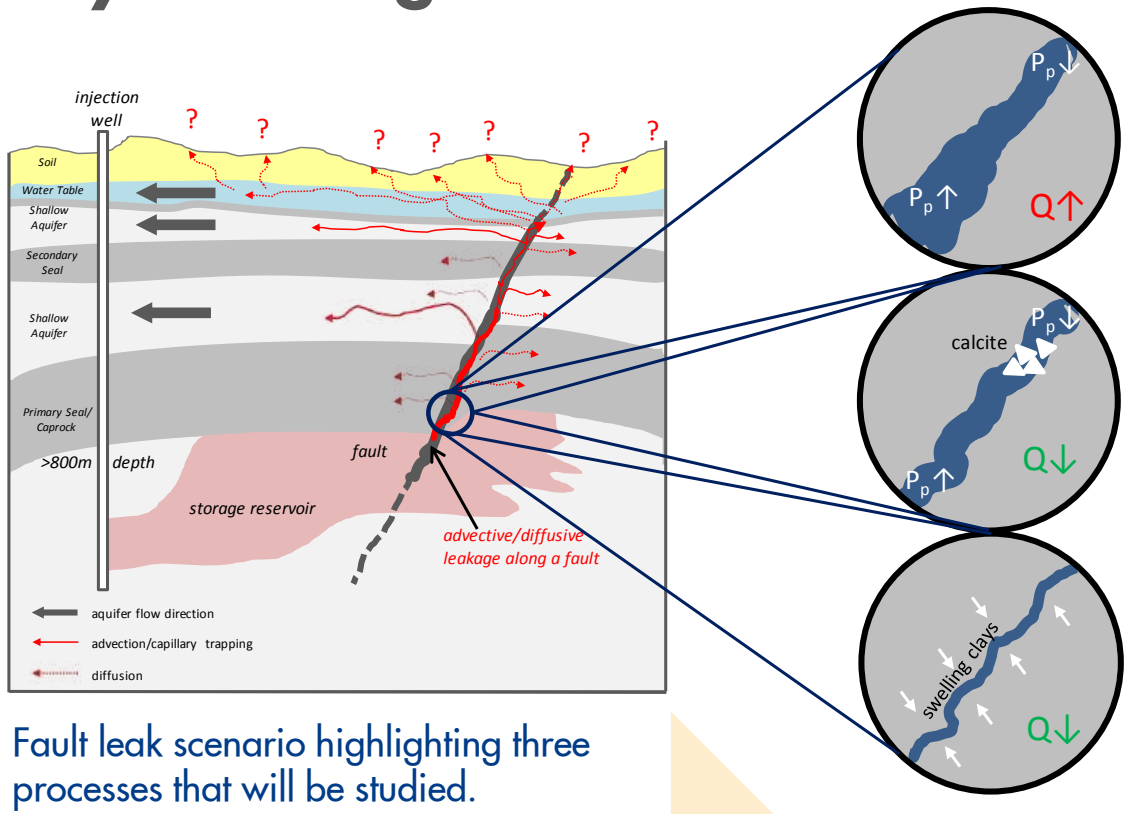
WP2 – Fracture Flow, Mineralisation, Clay Swelling

WP2 will test sensitivities of leakage rates along fracture networks or fault damage zones to fluid pressure, chemistry, mineral reaction rates, saturation changes and effective stress changes to generate the necessary input parameter for leakage modelling in WP3.

- **Objectives**
  - Identify and analyse factors controlling fracture flow as a function of temperature, pore pressure, confining stress, mineralogy or strength parameters
  - Significantly improve fundamental understanding of the impact of CO2 induced expansion of swelling clays in fractures
  - Determine effects of CO2-induced water-rock interactions on transport through fractures
- **Collaboration**
  - Heriot-Watt University, RWTH Aachen University, Shell IRD



Fault leak scenario highlighting three processes that will be studied.

WP2.T1. Fracture Flow: stress-permeability relations

WP2.T2. Mineralisation: mineralisation in fractures

WP2.T3. Clay Swelling: clay swelling affecting fracture apertures

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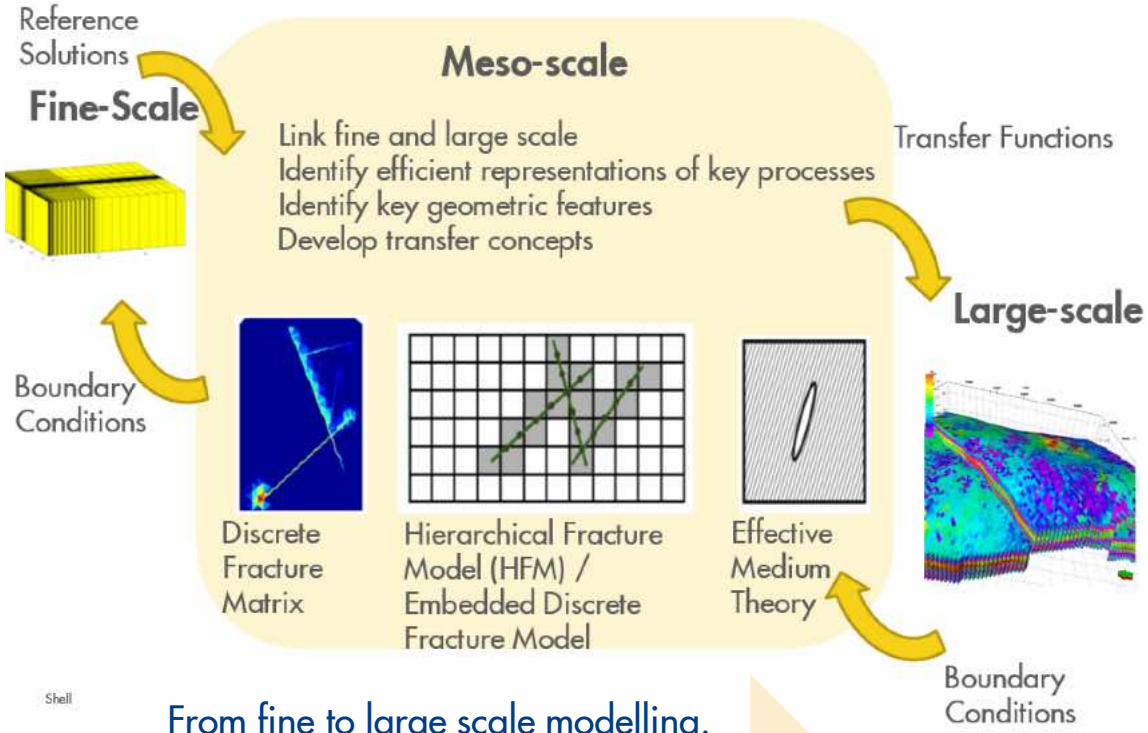
WP3 – Fracture Characterisation and Modelling

WP3 will characterise 2D/3D fracture network pattern for flow modelling. It will also perform innovative hydro-mechanical-chemical CO_2 and brine leakage modelling at fine-scale, meso-scale and large-scale. Results inform WP4 and WP5.

- **Objectives**

1. Develop and apply a predictive modelling workflow for realistic CO_2 and brine leakage rates along realistic fault/fracture damage zones through the primary caprock and continuing into shallower formations
2. Incorporating effects on fracture aperture of mineral dissolution/precipitation and clay swelling

- **Collaboration**
  - Shell IRD, Heriot-Watt University, University of Cambridge



From fine to large scale modelling.

WP3.T1. 2D/3D fracture network pattern characterisation for flow modelling	WP3.T2. Fine-scale modelling of flow in a single facture and connected matrix	WP3.T3. Meso-scale modelling and upscaling of flow in fault damage zones	T3.4. Large-scale fault zone leak path modelling of storage complexes

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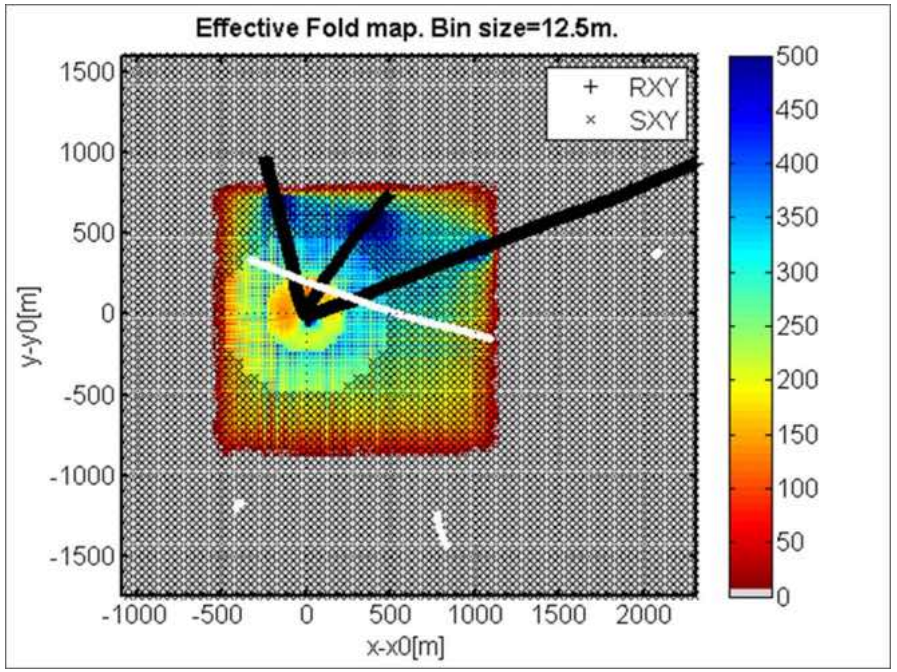
WP4 – Containment Monitoring for Caprock Integrity

WP4 will select cost-efficient and effective caprock monitoring technologies which will be incorporated as active safeguards in bowties and quantitative risk assessment models (WP5).

- **Objectives**

1. Identify which containment monitoring technologies can act as effective and efficient barriers to the risks posed by CO_2 leakage along fractures of the caprock
2. Give a comprehensive overview of selected containment monitoring technologies with their respective detection threshold ranges for a number of investigated leakage path scenarios

- **Collaboration**
  - Shell IRD, Risktec, CaMI.FRS, Otway Project



Goldeneye DAS VSP feasibility study.

WP4.T1 Overview of relevant containment monitoring technologies

WP4.T2 Identify monitoring technologies suitable to detect leakage across caprock

WP4.T3 Perform feasibility studies for selected monitoring technologies

WP4.T4 Identify detection thresholds based on results from T3 and other WPs

WP4.T5 Incorporate results as active safeguards in bowtie with WP5

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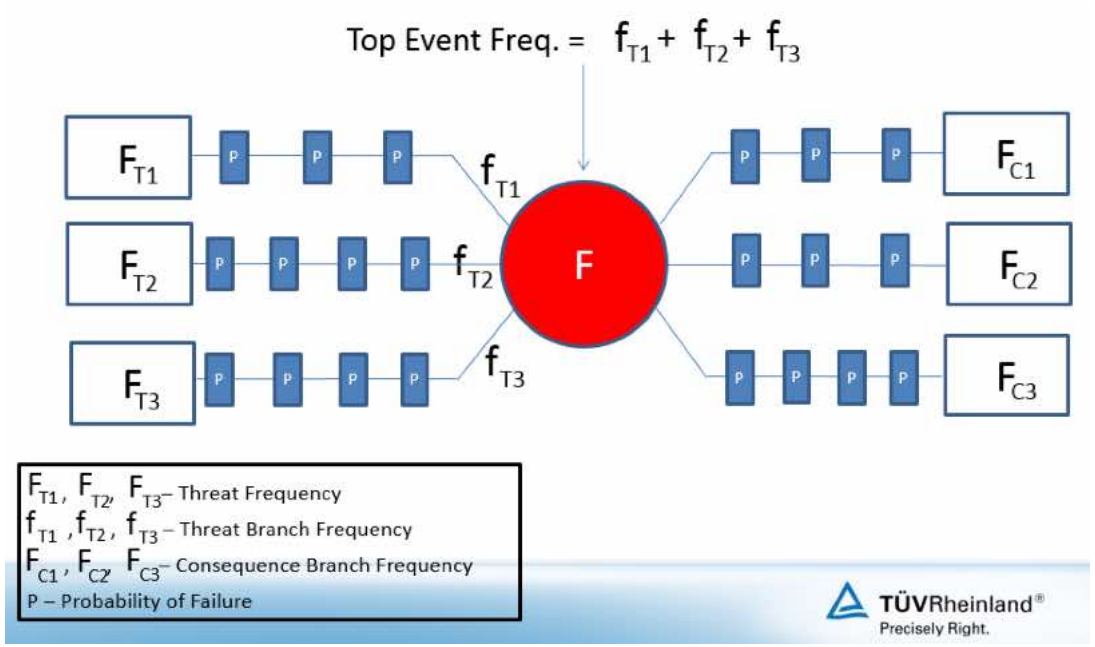
WP5 – Qualitative and Quantitative Risk Assessment

WP5 will integrate learnings from DETECT into qualitative and quantitative bowties to serve as an industry guideline for risk assessment of CO_2 leakage across fractures in the caprock.

- **Objectives**

1. To develop bowtie diagrams depicting the natural pathways for CO_2 release from subsurface storage and the measures in place to prevent/mitigate the risk
2. To develop a quantitative risk assessment model aligned to the bowtie, using output from the other WPs to determine prevention/mitigation measure effectiveness
3. To calculate relative risks of CO_2 leaking through caprock, enabling the model to be used for future site comparison/screening purposes

- **Collaboration**
  - Risktec (TÜV Rheinland Group), Shell IRD (build on learnings from Peterhead and Quest CCS projects)



An example of a semi-quantitative risk analysis model.

WP5.T1. Identify suitable quantitative bowties risk analysis models

WP5.T2. Bowtie risk assessment for different leakage scenarios

WP2.T3. Quantitative risk analysis for different leakage scenarios

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