Multidisciplinary Subsurface Workflow for CO_2 Injection in Depleted Gas Reservoirs

An integrated reservoir study for energy transition

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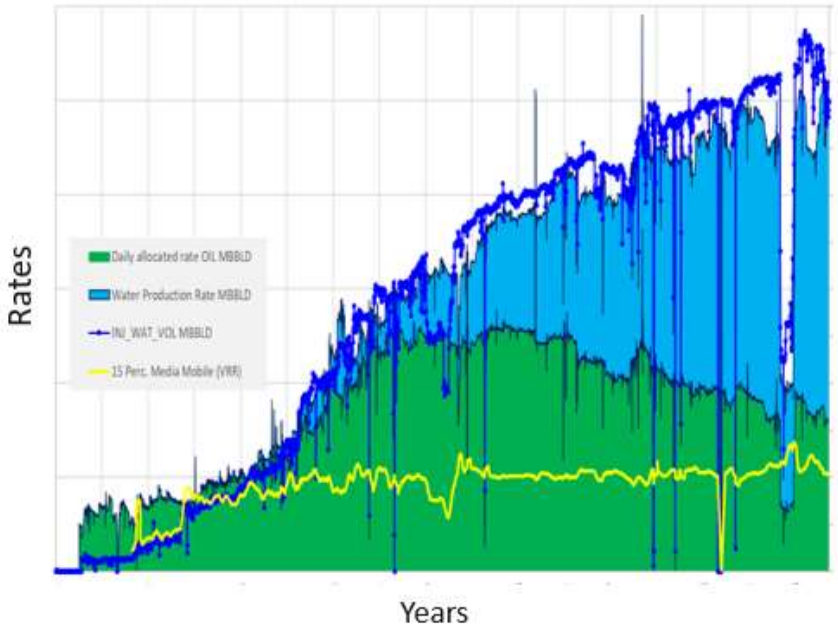
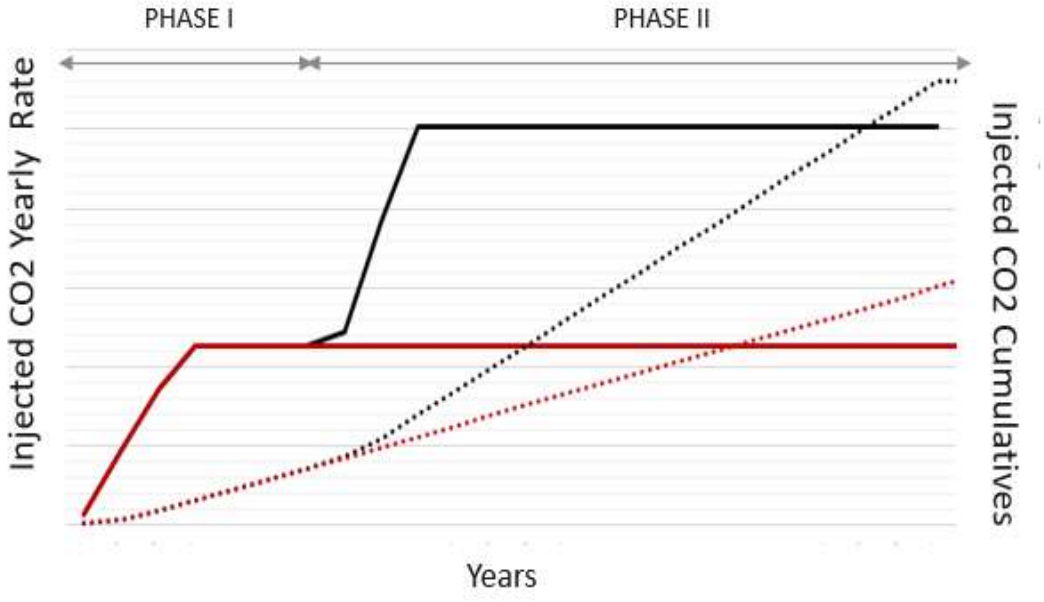
CCS Process Change of Perspective

Hydrocarbon production vs CO_2 storage profiles



Hydrocarbon Resource

- "An accumulation of petroleum naturally occurring on or within the Earth's crust"
- Subsurface is **upstream**. We must handle data to obtain the best development scenario



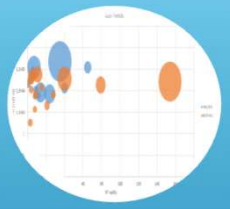
CO_2 Storage Resource

- "The ability to accommodate and retain CO_2 in the subsurface"
- Subsurface is **downstream**. We must manage subsurface uncertainty to give a guaranteed outcome

CCS Studies Integrated Workflow

From studies ... **...to application**

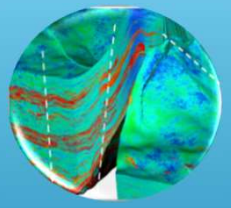
CCS Screening



Analitical formulation

Material Balance evaluation

3D Reservoir Model



Injection site characterization

Dedicated Static model & HM

Injection profile

Plume Evolution

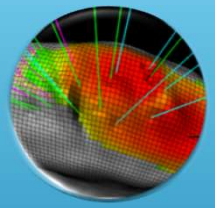
Laboratory Analyses

PVT

Relative Permeabilities

Rock mechanical parameters

Uncertainty Analysis



Impacting Parameters Identification

Uncertainty Maps

Special Studies

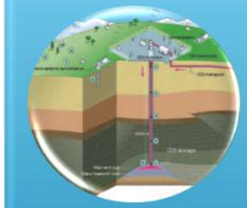
Cap rock integrity

Fault stability

Thermal Induced Fracture

Mineralogical and Geochemical

Full scale application

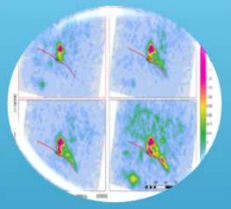


Drilling & Completion

Flow Assurance

Contracts & Third Parties Relationships

Monitoring



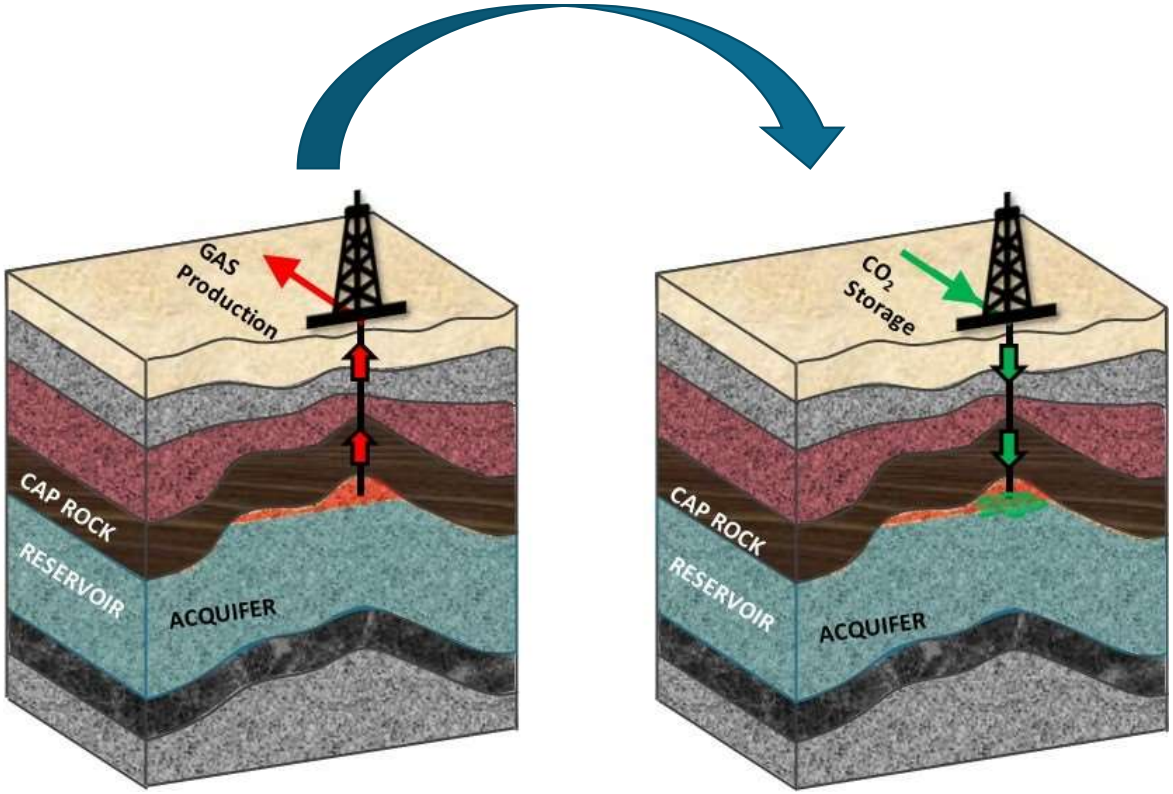
Environmental

Microseismic

Plume Evolution

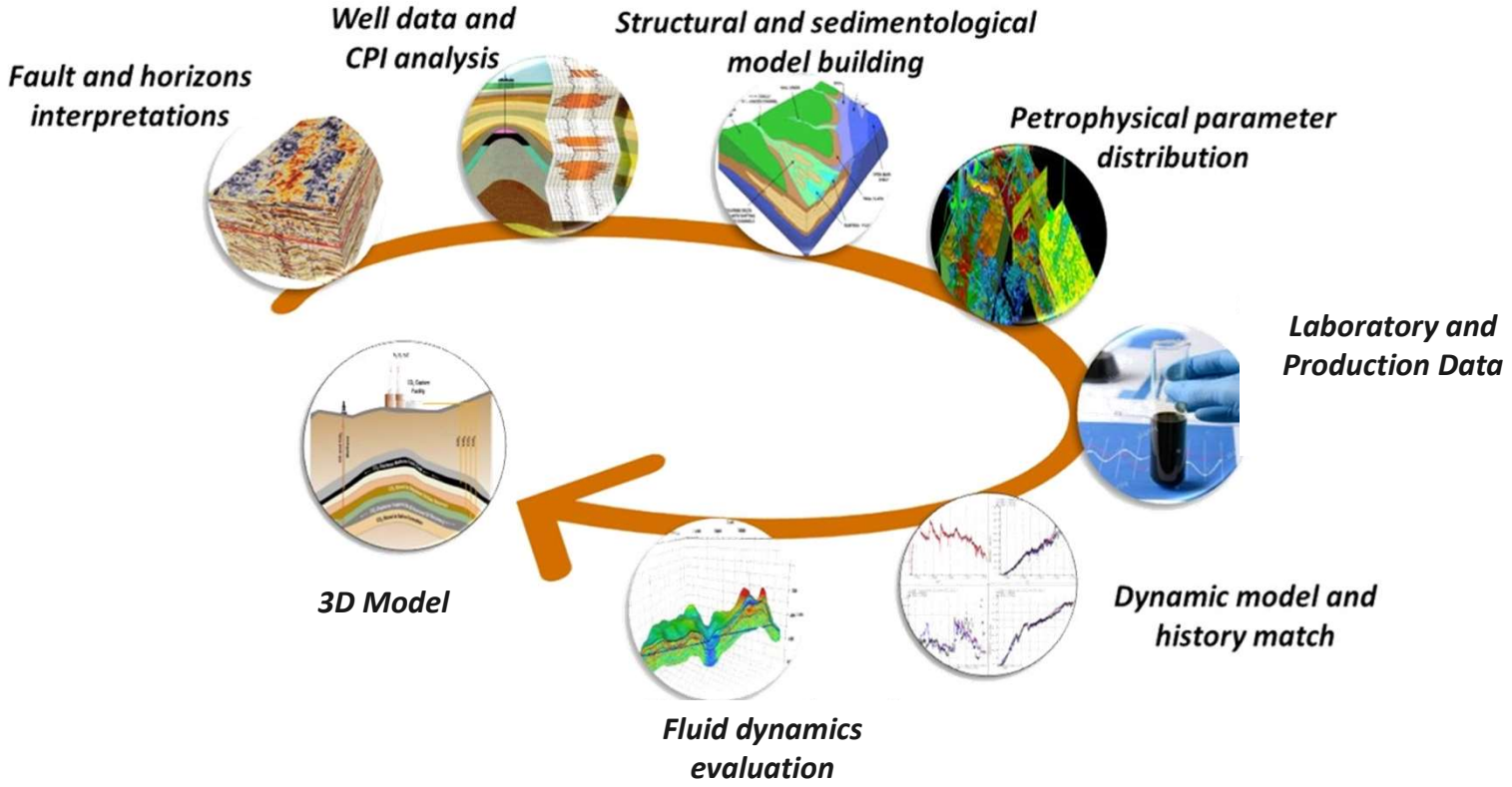
Why depleted reservoir for CCS?

From gas production to CO_2 storage



Knowledge and predictivity	Extensive field knowledge and available 3D model
Facilities	The present infrastructure could be used for injection
Injectivity	Tested in years of production
Containment	Natural process proven by hydrocarbon accumulation

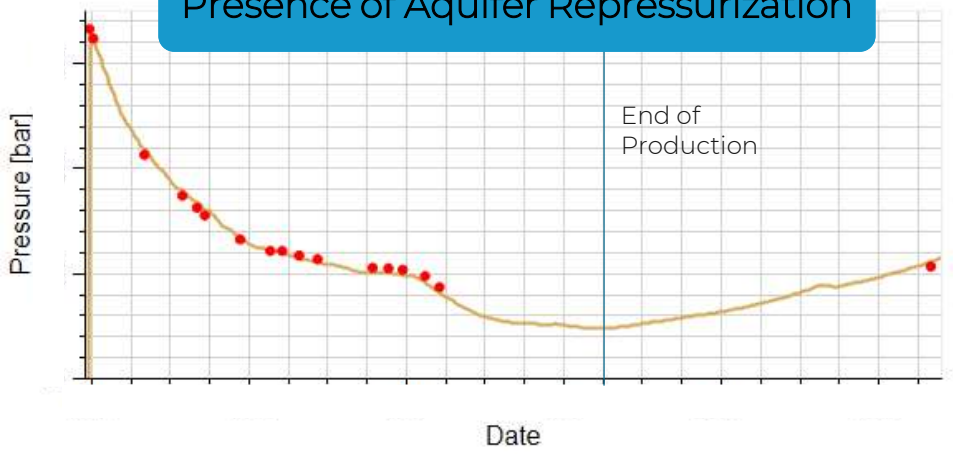
3D Reservoir Model Construction



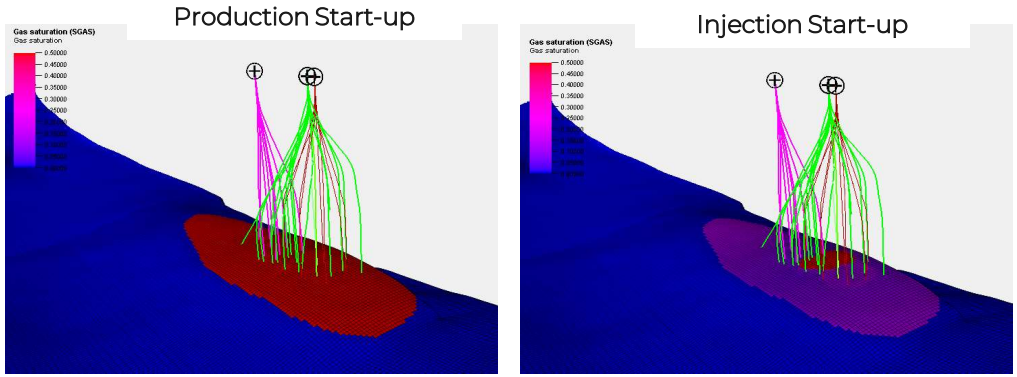
Predictive models to support appropriate monitoring plans compliant with International Standards and local regulations

History Match Process

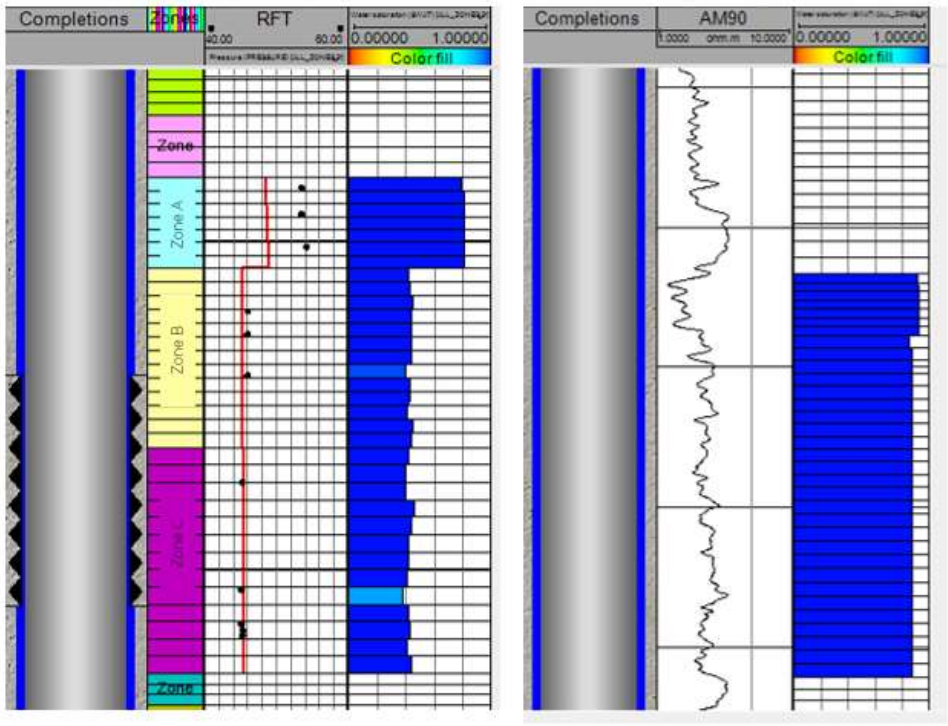
Presence of Aquifer Repressurization



Resevoir Fluids Description



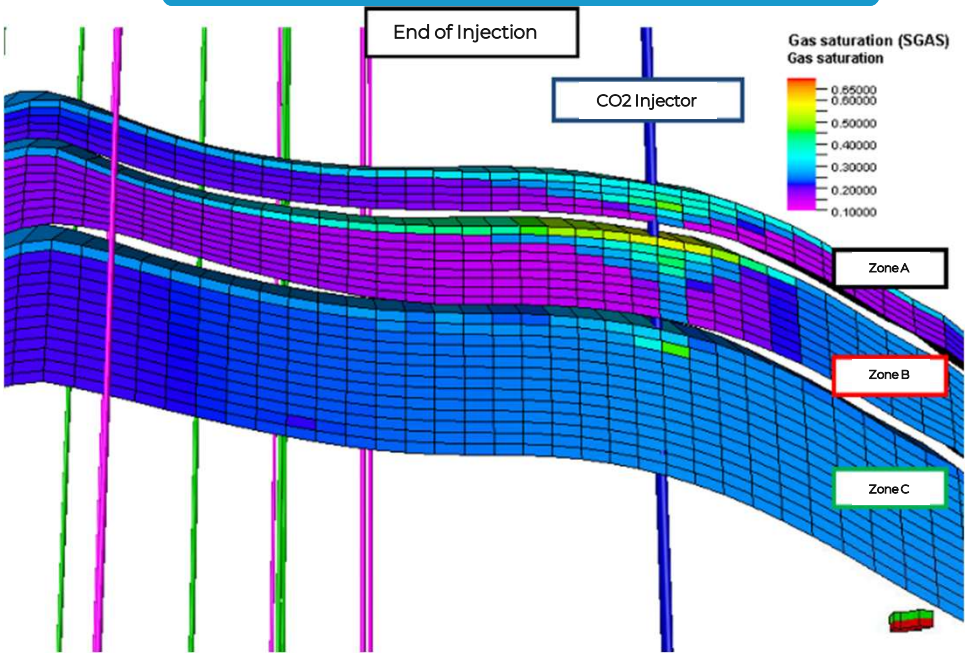
Well Data Matching



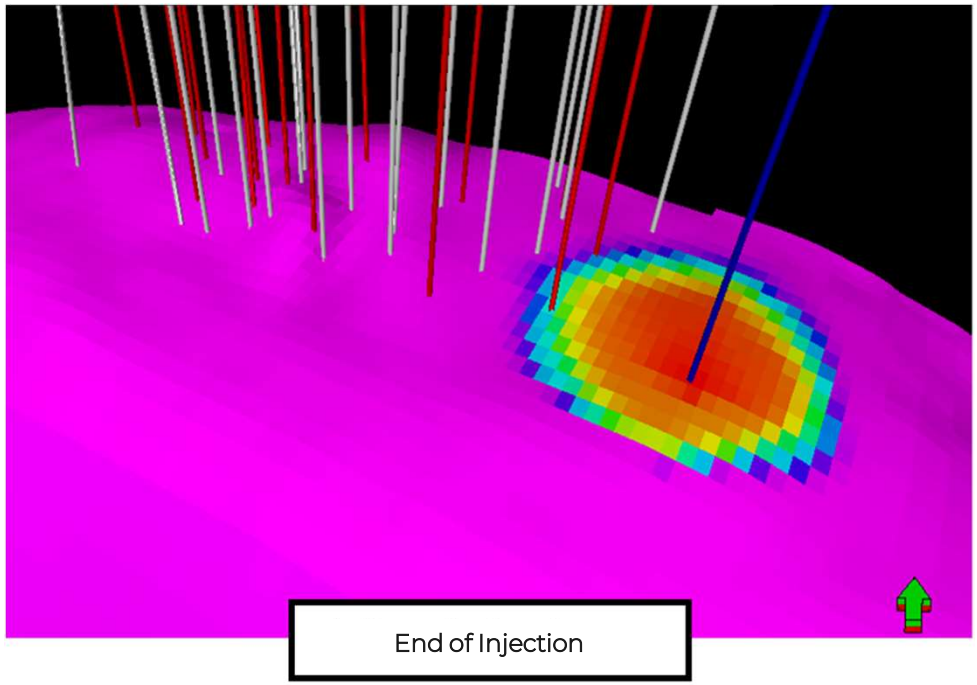
History Match dedicated to pressure and fluid characterization at the injection start-up

CO2 Injection and Plume Evolution

Injectivity & Pressure Evolution



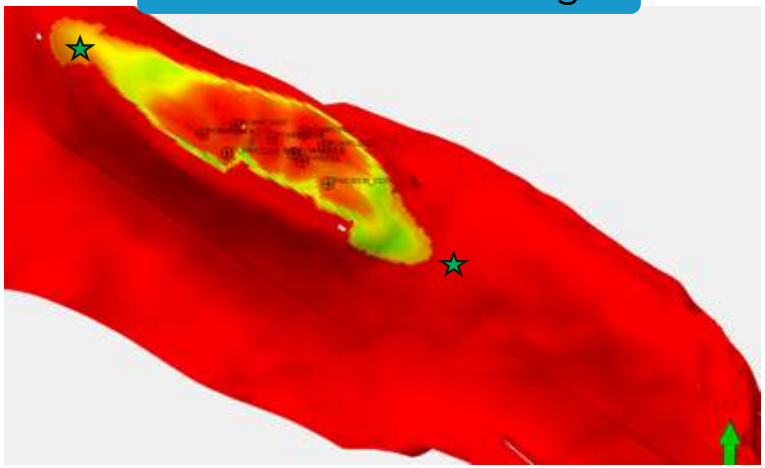
Plume Evolution



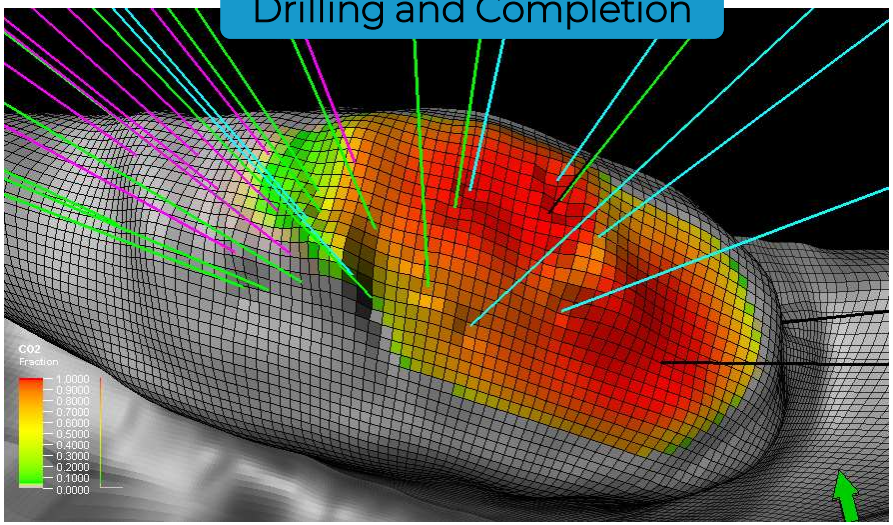
CO_2 Injection Forecast Focus on Injectivity, injector locations and CO_2 plume evolution

Uncertainty Analysis

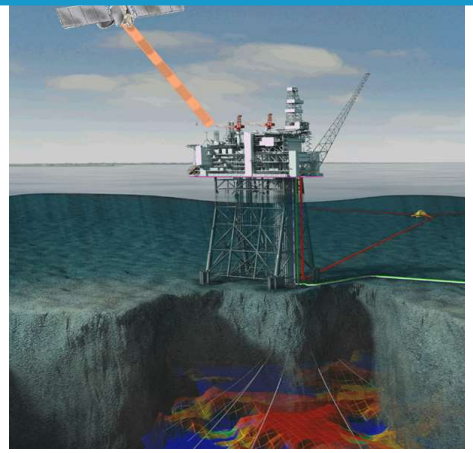
Reservoir Monitoring



Drilling and Completion



Environmental Monitoring



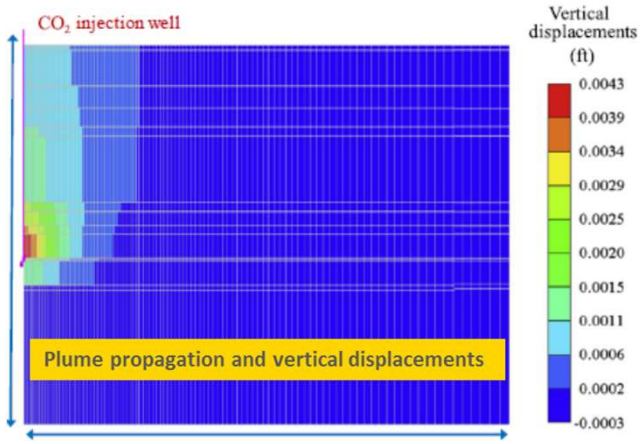
Uncertainty Analysis provides key elements:

- most impacting parameters
- uncertainty maps that can be used during monitoring phases

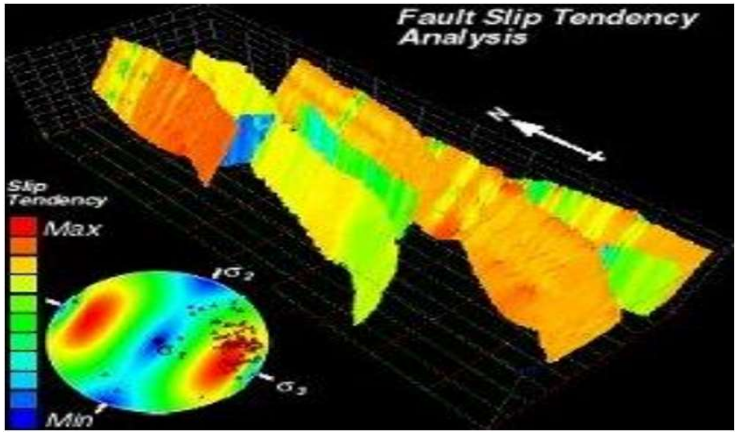
and it is a usefull tool in finding preferential CO_2 migration paths

Geomechanics

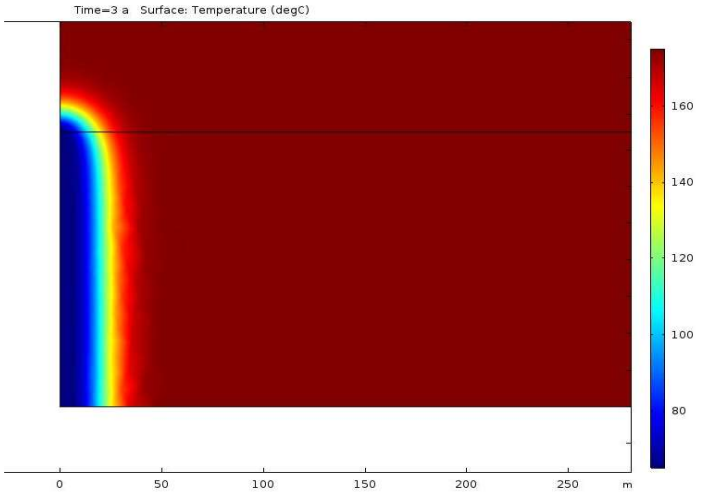
Cap rock Integrity



Fault Stability



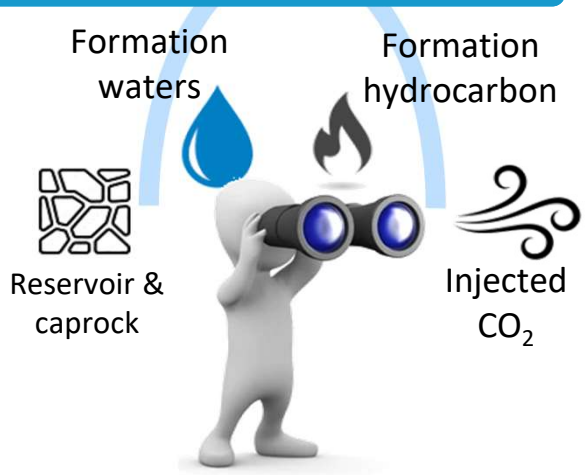
Thermally Induced Fracture (TIF)



Geomechanics studies are mandatory and provide information about reservoir behaviour and cap-rock containment

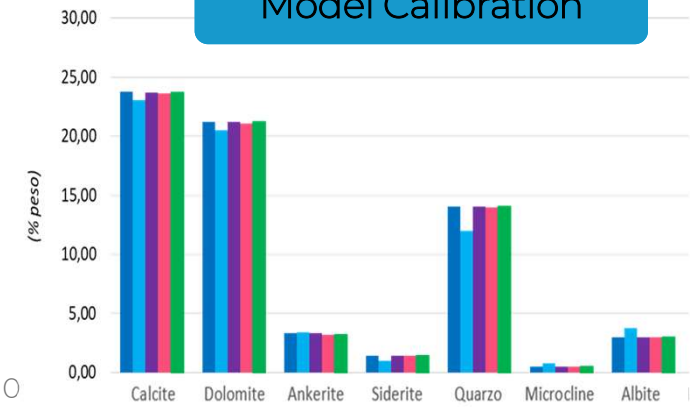
Mineralogical and Geochemical

Geochemical Characterization



CO2 Ageing Experiments

Model Calibration



Calibration via caprock samples ageing experiments without and with CO_2 to quantify reactive processes

Calibration of kinetic reactions in numerical geochemical models

Conclusions

- An **integrated subsurface workflow for CO2 injection** study has been presented
- Reservoir is located **downstream** the whole CCS process
- The workflow can be **easily applied** on **depleted gas reservoirs** and foresees:
  - Compositional high resolution **3D Reservoir model** (Geological and Dynamic) with focus on fluid characterization at the injection start-up
  - Dedicated forecast process with focus on **injectivity**, injector locations and **CO2 plume** and pressure **evolution**
  - **Uncertainty analysis** performed to provide key elements on CO2 migration preferential paths
  - Labs and Special studies to ensure **safe containment** during operation and beyond
- The approach appears particularly effective and may establish a benchmark that can be used for future initiatives