Characterisation of European CO_2 storage

Applying the workflow to the building of the static model

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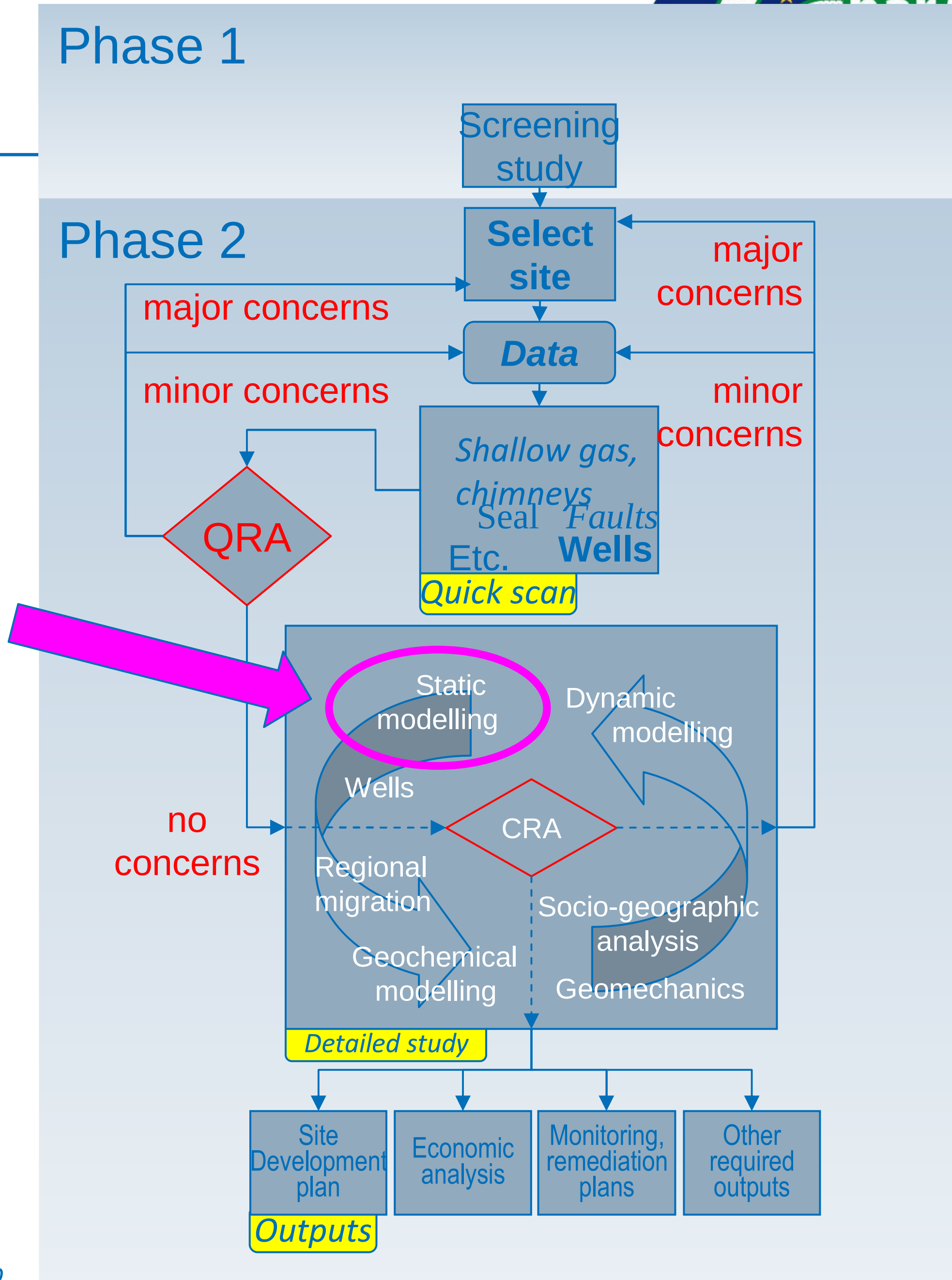
Site Characterisation

- **Static model - Workflow**

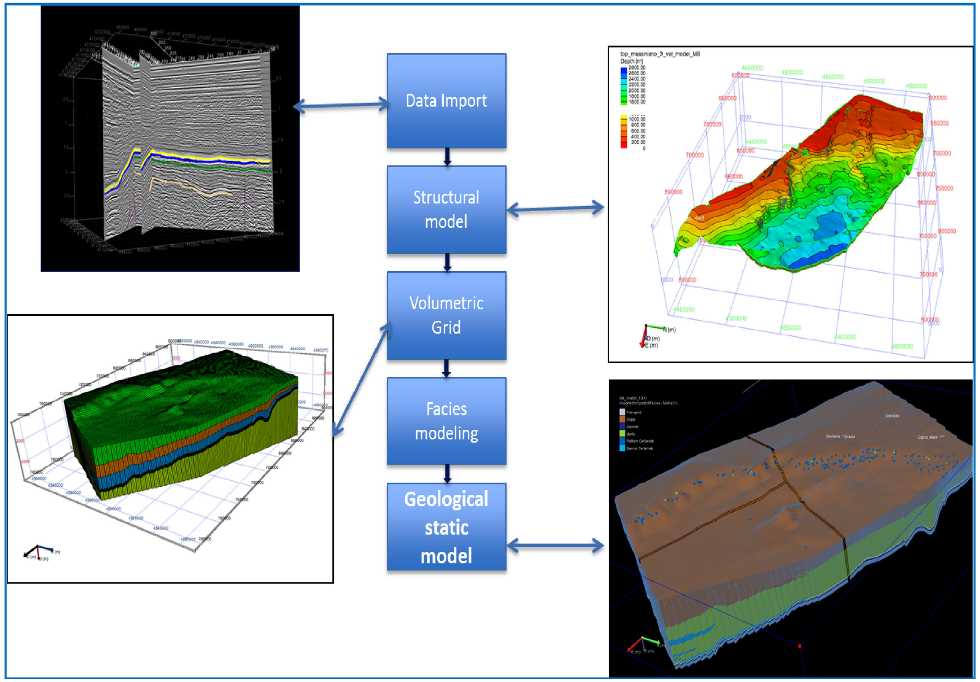
The objective of the static modeling is to create a computerized representation of the subsurface based on geophysical and geological observations.



Site Characterisation – Static modeling

▪ Static model building process

- Collection of data (seismic data, borehole data, scientific papers..)
- Data interpretation
  - Geological model
    (seismo-stratigraphic interpretation)
  - Stuctural model (faults)
- Time – depth conversion
- Volumetric gridding
- Facies distribution
- Population with petrophysical properties



Site Characterisation – Static modeling

- ## Data input
  - **1. Basic input data**

(data not resulting from other technical disciplines)

Data	Source	Usage
Previous seismo-stratigraphic and structural interpretation	Interpreted seismic data	Construction of 3D geological model at basin scale and reservoir scale
Seismic survey data	3D or 2D seismic survey	Interpretation of faults and stratigraphic surfaces.
Core data	Measurements on core samples taken in wells	Define the petrophysical distribution within the geological formations
Well log data	Physical measurements recorded in well	Define the petrophysical distribution within the geological formations
Porosity	Measurements on core samples taken at wells or derived from logs	Define the porosity distribution within the geological formations
Permeability	Measurements on core samples taken at wells or derived from porosity and/or logs	Define the permeability distribution within the geological formations
Interpreted faults	Interpreted seismic data	Define the fault pattern at the local (site) and regional scale
Mineralogy	Laboratory analysis on cores	Define distribution of geochemical properties
Hydrocarbon field/ HCIIP	Oil field reservoir parameter	Initial estimate of storage capacity
Outcrop data		Measure rock properties of analogue strata if material is not available for the selected geological formations
Fluid information	Pore water properties measured in well or on samples	Geochemical properties of the fluids within the reservoir
Well tops (stratigraphic interpretation of well log data)	Well log interpretation	Seismic data interpretation
Occurrence of shallow gas or gas chimneys	Baseline obtained from high resolution acoustic data	Identify possible gas leakage pathways related to the geological model
Geological knowledge from existing published papers	Bibliography	Geological- structural setting of the investigated area
Evidence of natural fluid flow to surface (that may already be described)	Baseline obtained from high resolution acoustic data	Construction of 3D geological overburden model

Site Characterisation – Static modeling

- **Data input**

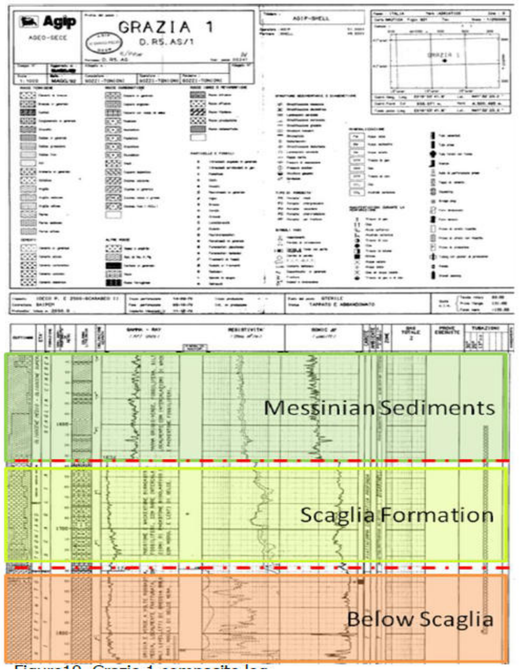
  - **2. Input from other workflow elements**

Input	Source	Usage
Results from lab experiments (porosity and permeability)	Geochemical study, petrophysical experiments	Update the petrophysical properties distribution
Results from history match	Dynamic modelling	Update static model

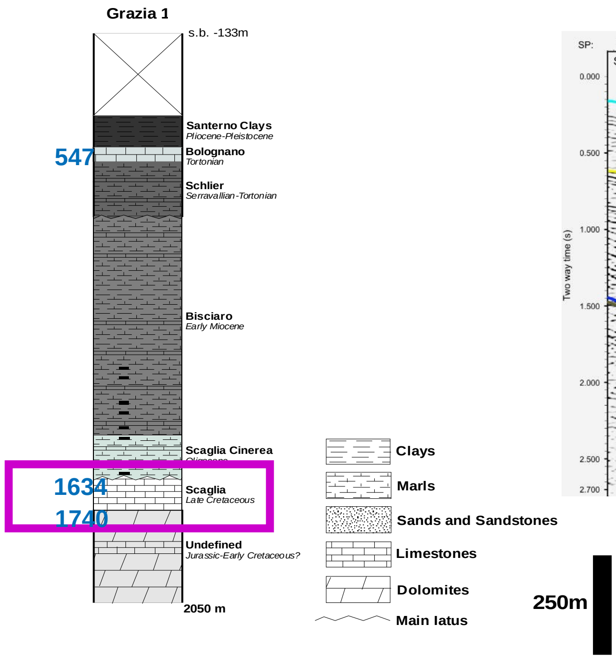
Site Characterisation – Static modeling

- **Data interpretation**
  - **<u>Seismo-stratigraphic interpretation</u>: analyse the well information so as to calibrate the stratigraphic surfaces along the seismic profiles.**

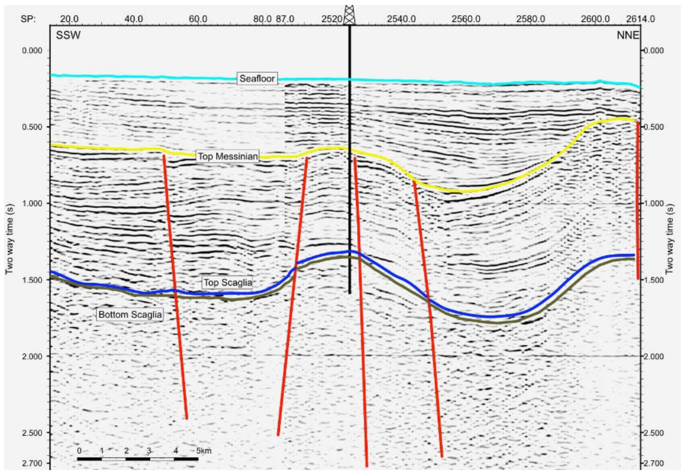
Well log chart



Stratigraphic interpretation



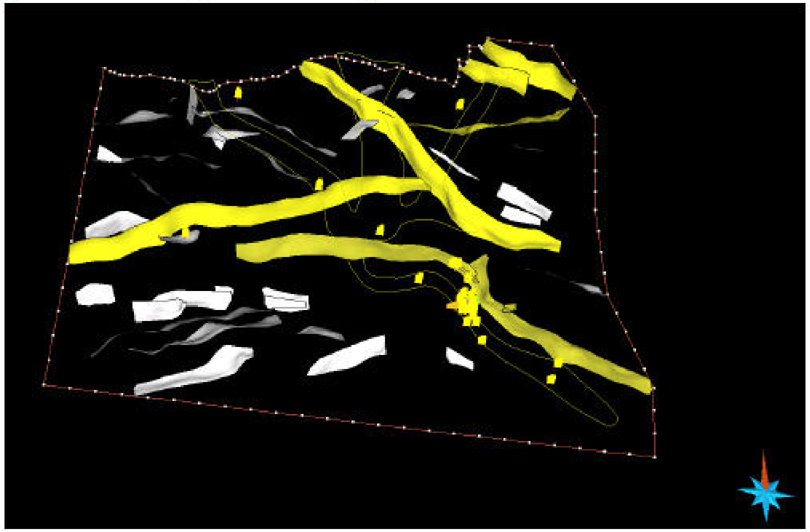
Seismic interpretation



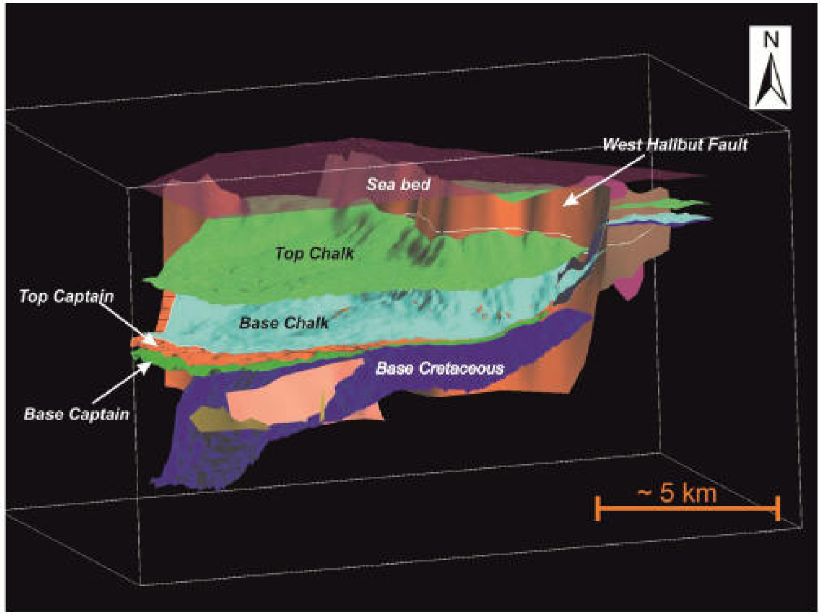
Site Characterisation – Static modeling

- **Geological model**

3D model of faults network



3D model of the seismic surfaces

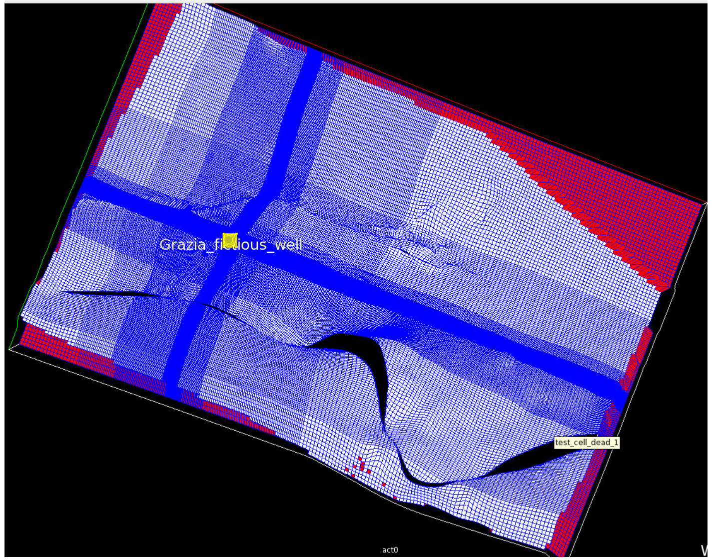


Example from Scottish site

Site Characterisation – Static modeling

- **Time (seismic) conversion to depth**
  - **Seismic data being recorded in time, the interpreted horizons are expressed in two-way time (TWT) velocity model is created to enable depth conversion.**

- **Volumetric gridding**
- **the structural model is then split up in a finite number of boxes/cells (volumetric grid), each of them will then be characterized by proper lithological, petrophysical and geomechanical properties.**

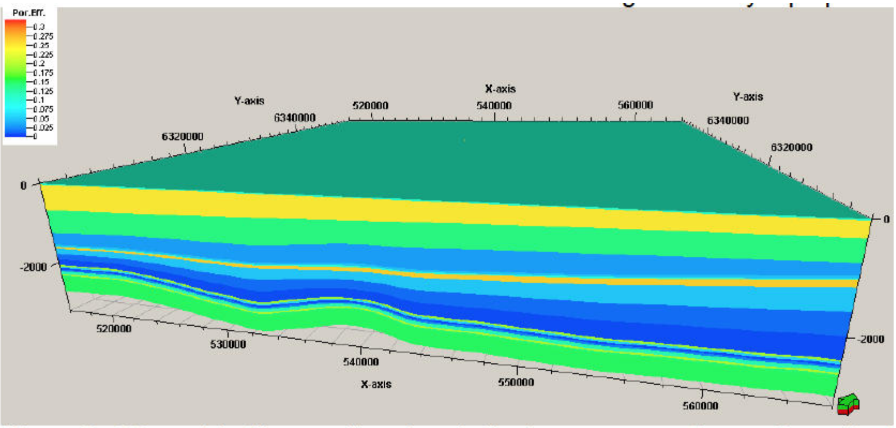


Site Characterisation – Static modeling

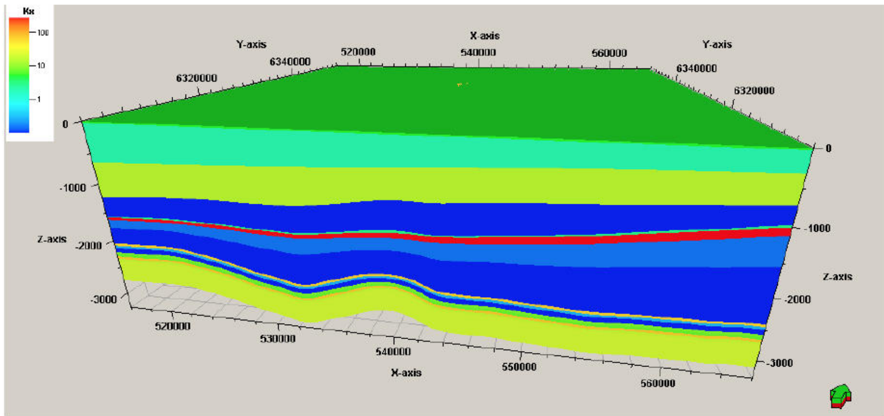
- **Volumetric grid populated with petrophysical properties**

3D model with regular x-y grid in 200x200 m ,11 horizons and 10 zones. The layering has only been refined for the Gassum reservoir and the overlying thick caprock, section of the Fjerritslev Formation (8 and 3 layers respectively).

Porosity distribution



Permeability distribution



Examples from Danish site

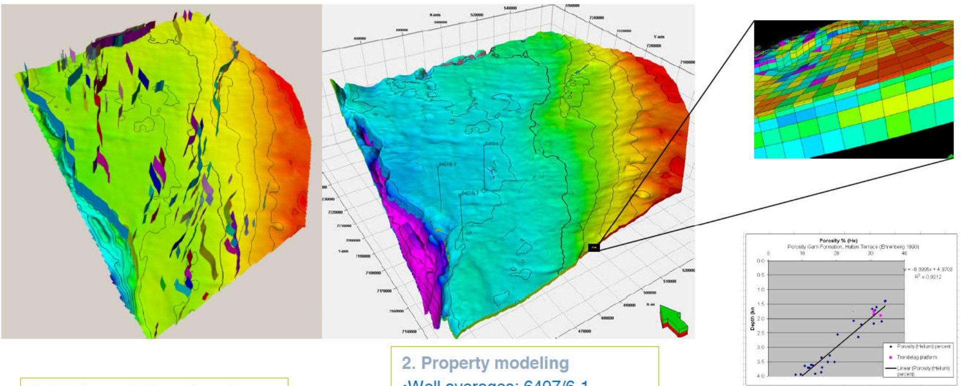
Site Characterisation – Static modeling

■ Links with other workflow elements

- The attributed **static model output is input for the dynamic flow, geomechanical and geochemical modelling**. A suitable model of the storage complex is thus necessary to define the appropriate parameters that will be used for the next modelling activities.

- The static model building should be "dynamic", in the sense that as new information becomes available, the model has to be updated so as to produce a reliable geological model.

Trøndelag Platform

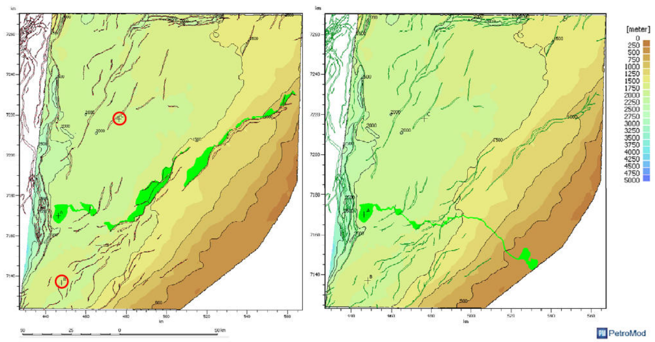


1. Static modeling: **Garn Fm**.
•Cell size: 200x200m
•Uniform thickness 127 m
•Nr of faults: 32

2. Property modeling
•Well averages: 6407/6-1, 6408/4-1, 8407/9-7
•NTG: Gaussian Random Function
•PHI: Porosity –Depth curve
•K: Linear transformation PHI

3. Upscaling
cell nrs: 14M → 240 k

Migration path analysis



- No capillary/residual trapping.
- No CO_2 dissolution in brine.

Example from Norwegian site

Site Characterisation

- **Uncertainties and risk factors**
  - **The static model provides information mainly related to the geological assessment of the storage complex, from which possible risk factors and technical conditions not favourable for storage can be derived**

Uncertainties

Well data provide local information which are extended areally using seismic data..poor data quality increases the uncertanties

Risk factors

- Low porosity that will lead to low CO2 storage capacity;
- Low permeability that may generate injectivity issues;
- Cap rock integrity, where the seal rock condition is not well known

The impact has to be estimated: solutions economically feasible?

Site Characterisation – Static modeling

- **Key concerns**
  - **Data : High-quality data are needed. This influence the detail of the analysis that can be conducted and the detail in the representation of the storage site. Data from hydrocarbon exploration are important.**
  - **How many models: update the static model accordingly with new data or to deem requirements from other disciplines**
  - **Model extent: the model should include the whole storage complex and the so-called affected area.**
  - **Model resolution: it depends on the data resolution. Vertical resolution is an issue for dynamic simulation: vertical refinement is recommended where necessary (reservoir, around wells and faults…)**
  - **Software: recommended use of standard industry softwares to avoid incompatibility problems.**

INTERACTION WITH DIFFERENT TEAM OF EXPERTS