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CO_2ReMoVe NGO-Research dialogue workshop Wednesday, February 23rd 2011 - Brussels

Methods and answers from performance assessment: what they are worth.

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Outlines

- CO_2ReMoVe objectives and challenges
- CO_2ReMoVe work program context
- Site performance assessment (PA)
    - PA worflow
    - Reservoir pressure: focussing on a key parameter (as example)
    - Illustration of reservoir pressure modelling and monitoring verification with the In Salah case
- Conclusions

CO_2ReMoVe objectives and challenges

- Demonstrate long term reliability of geological storage of CO_2
- Undertake the R&D necessary to establish scientifically based standards for monitoring future CCS operations
- Provide scientific information to develop best practices and guidelines

- Development of practical guidelines for monitoring and verifying
- Development of underlying performance assessment and monitoring tools and methodologies able to predict and measure the key operational and long term processes for CO_2 geological storage while designing remediation strategies if required

CO_2ReMoVe Work program context

- A strong partnership involving research institutes, universities, oil and gas operators and industrials concerned by reducing their CO_2 emissions (at least 27 partners) representing a wide spectrum of expertises and experiences in previous CCS projects and other domains

- Involvement on a portfolio of three industrial-scale storage sites (Sleipner, In Salah and Snøhvit) and other pilot sites (Ketzin, K12-B...)

- A general and scientific dissemination approach completed with a training action making possible exchanges with younger scientists

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Performance assessment of CO_2 storage

- Definition as considered in CO2ReMoVe:

"an analysis of the degree of containment of CO_2 in an anticipated CO_2 storage reservoir over appropriate time scales"

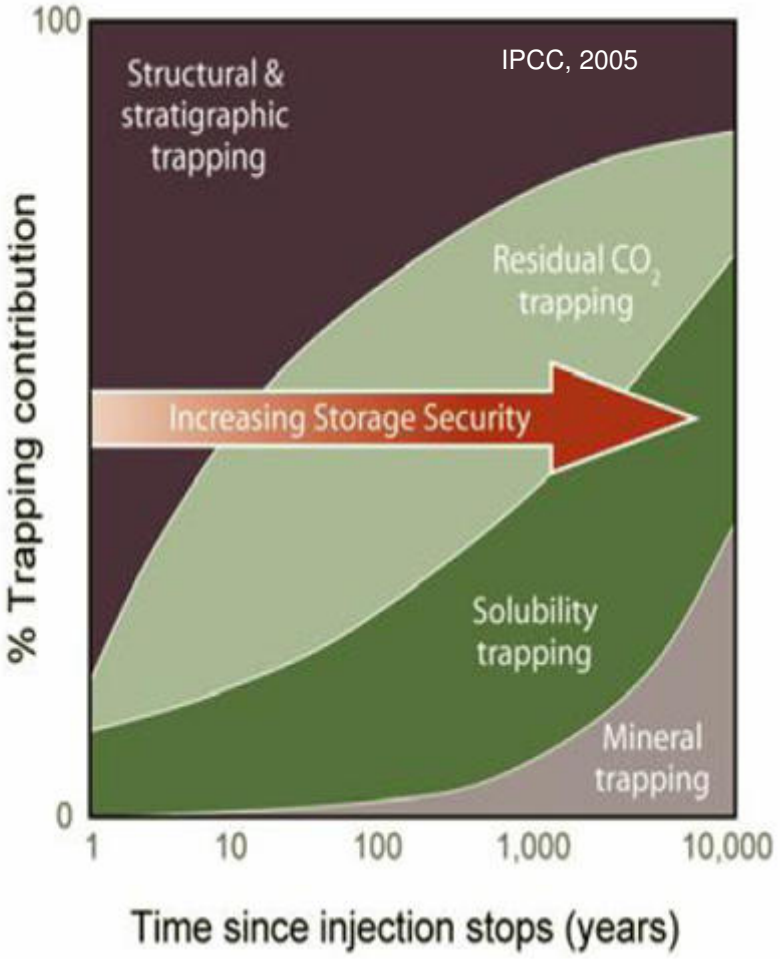
- Actions do deal with:
  - prediction of CO_2 migration and risk of leakage at short and long terms
  - understand CO_2 injection induced effects and storage (in situ modification of pressure, stress, fluid composition, reactive transport...)
  - mapping of the CO_2 plume and monitoring of induced phenomena to verify assumptions and to detect any leakage through wells, caprock, geological structure heterogeneities (fracture, fault...)

Site Performance Assessment of CO_2 geological storage: CO_2ReMoVe research challenges

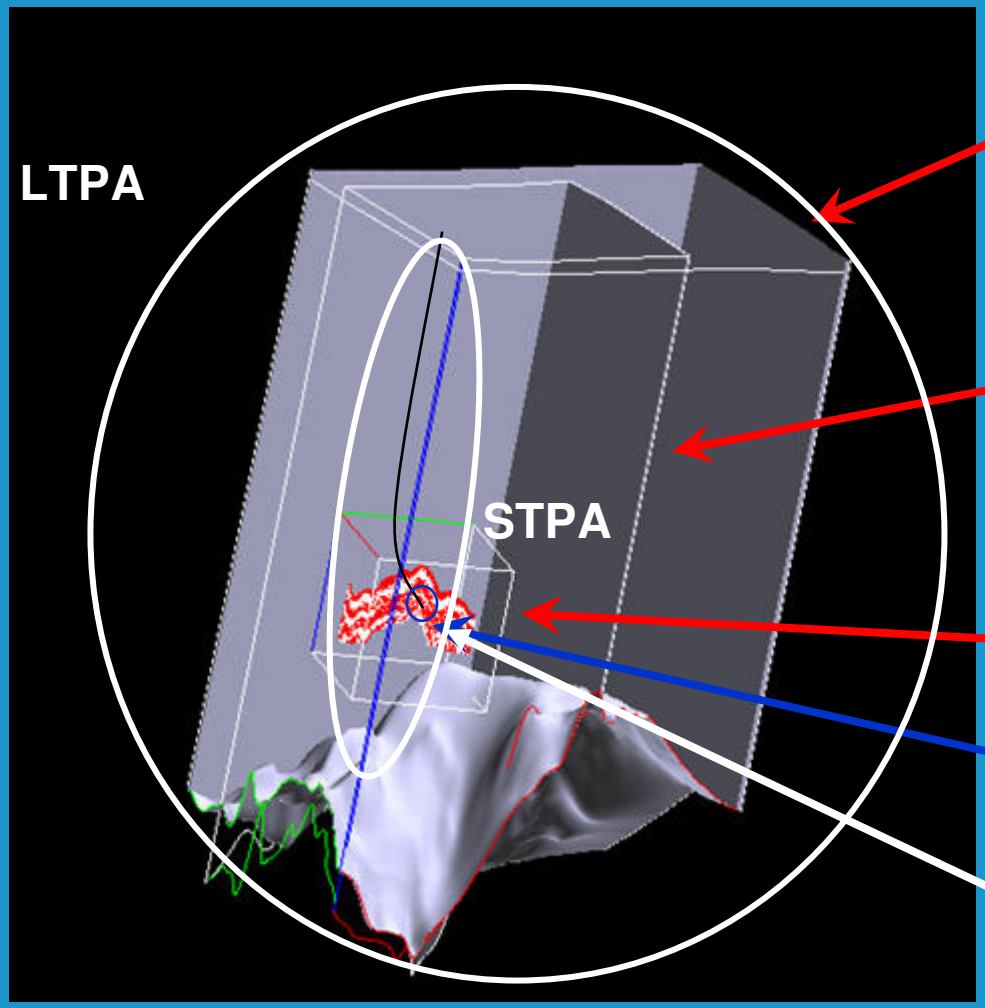
- Developing and testing a formalised methodology and tools for PA and mitigation of sites for short and long term safety and reliability prediction.

- Assuming multi physics phenomena for CO_2 migration and sequestration

→ 3D coupled reservoir, geochemical and geomechanical modelling (optimization required)



A multi-scale study for both space and time considerations



Basin scale

Interactions with other basin fluid exploitations: oil & gas production, gas storage, geothermal site

Storage Complex scale

Fluid migration and pressure dissipation

Reservoir storage scale

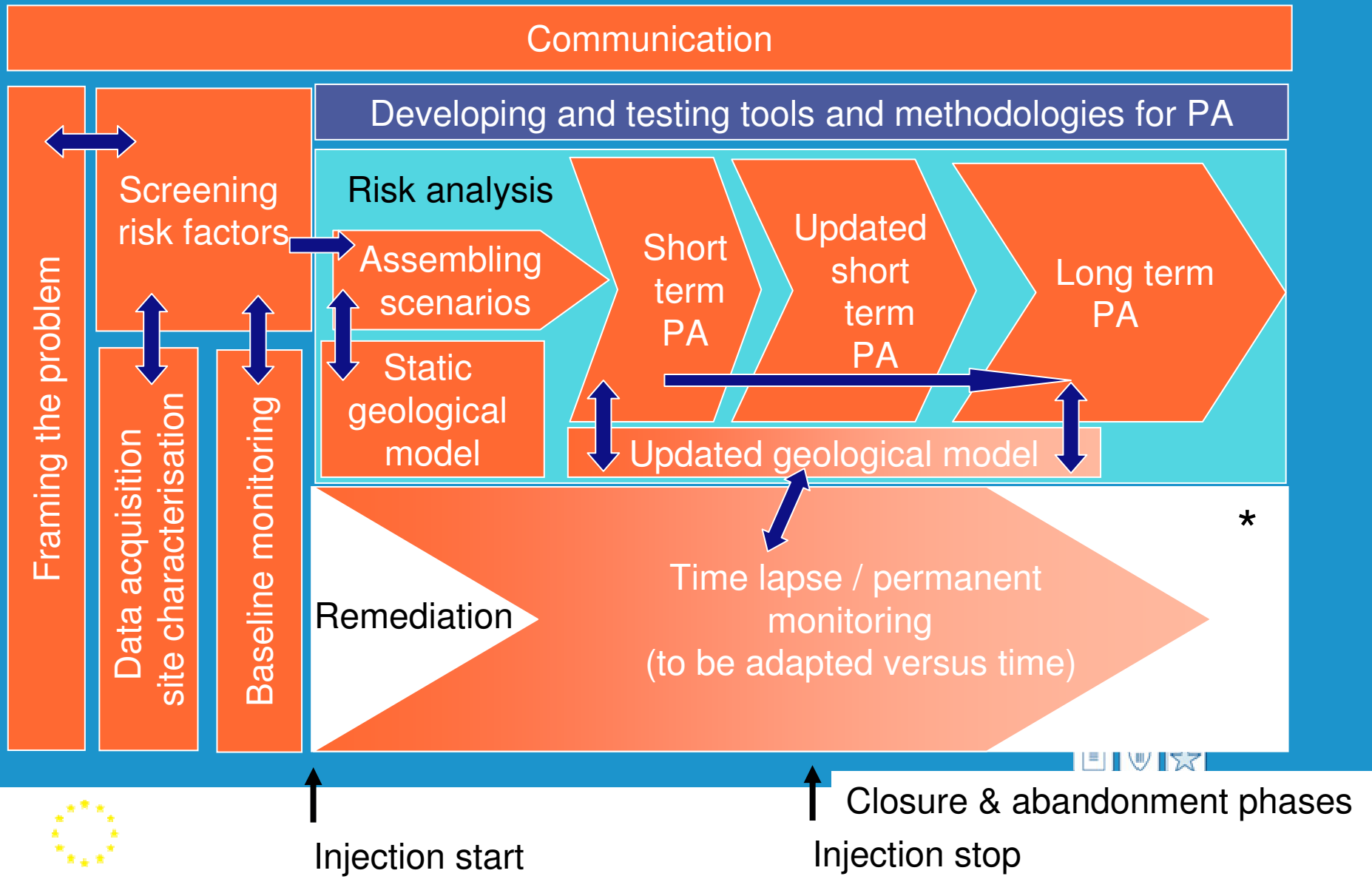
Anisotropy and heterogeneity

Near wellbore scale

Injectivity

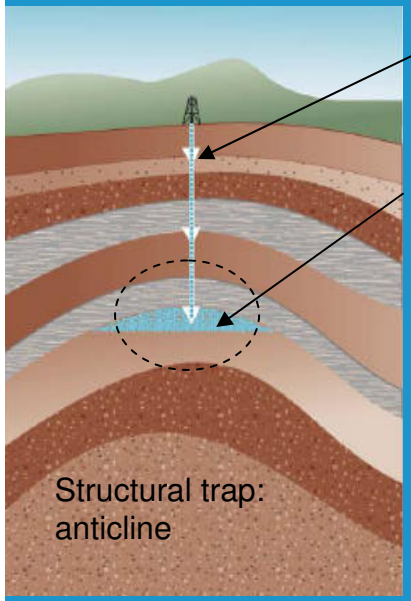
Pore scale

Site performance assessment workflow in the frame of CO_2 geological storage



CO_2 Storage key parameters

modifying in situ pressure (P), temperature (T) and fluid composition



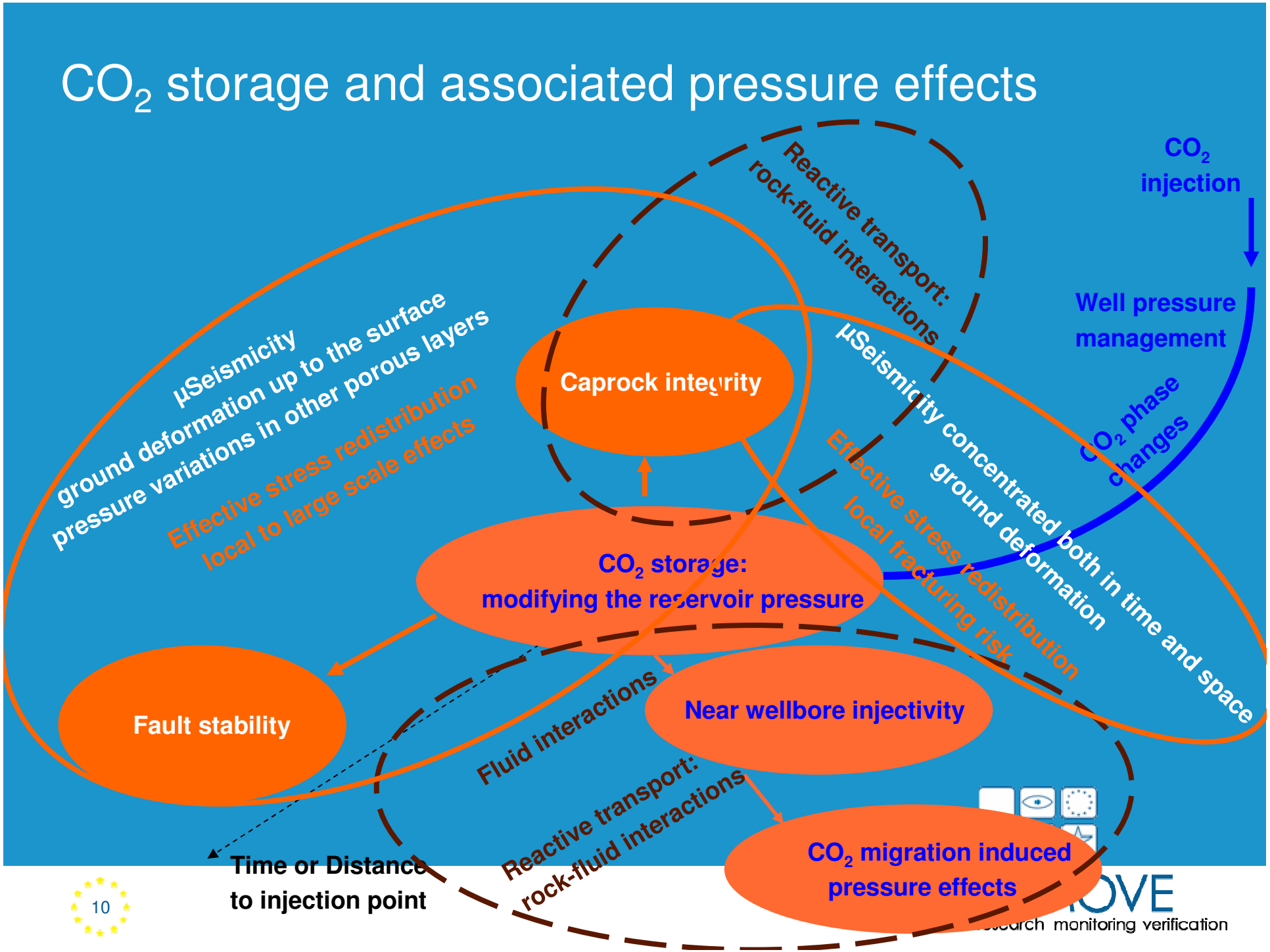
- Characteristics of the CO_2 stream (considering impurities)
- Storage site characteristics
  - Storage capacity (V, P, T, k...)
  - Reservoir injectivity (k, P, Q...)
  - Fluid migration within the storage complex (P...)

Storage integrity

Maximum acceptable pressure for efficiency without any inducing unsuitable geomechanical effect to preserve storage integrity

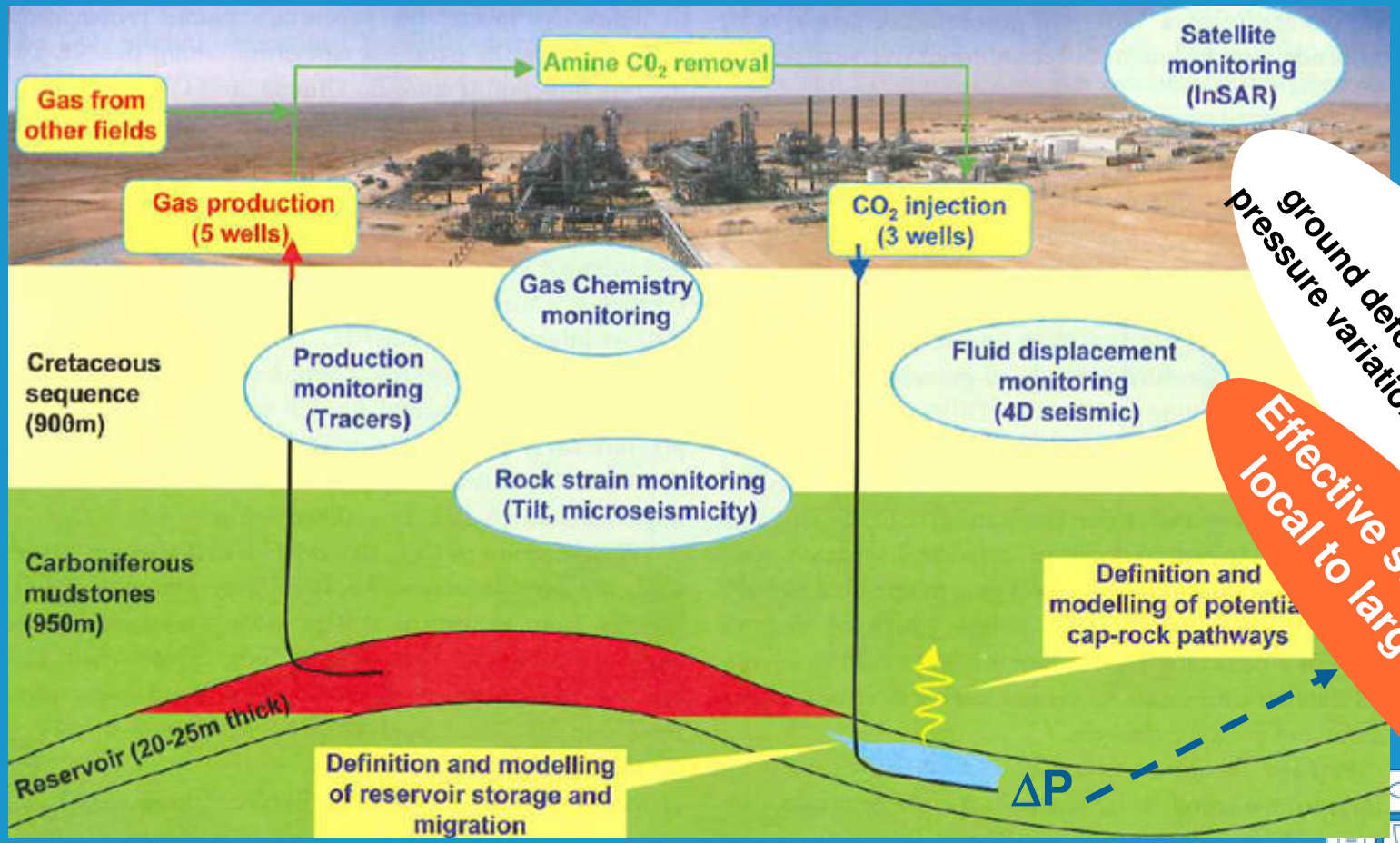
Reservoir pressure prediction:
a key step in CO_2 storage modelling

CO_2 storage and associated pressure effects



CO_2 storage and induced pressure effects: In Salah

Storing CO_2 while producing natural gas



µSeismicity
ground deformation up to the surface
pressure variations in other porous layers

Effective stress redistribution
local to large scale effects

Courtesy of In Salah JV: BP, Statoil and Sonatrach

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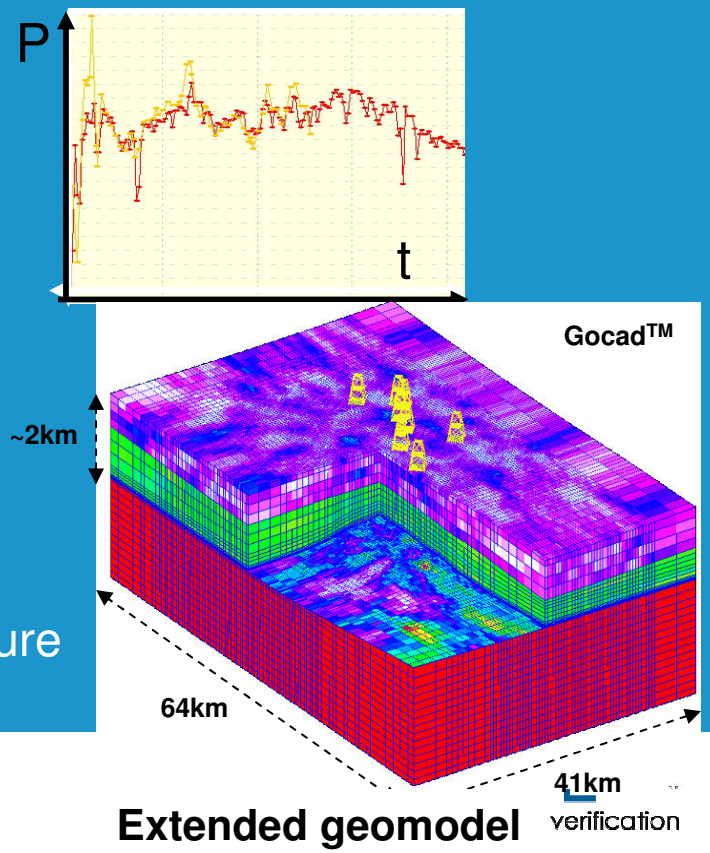
CO_2 storage in association with gas production: the In Salah case (CO_2ReMoVe project results)

Target:

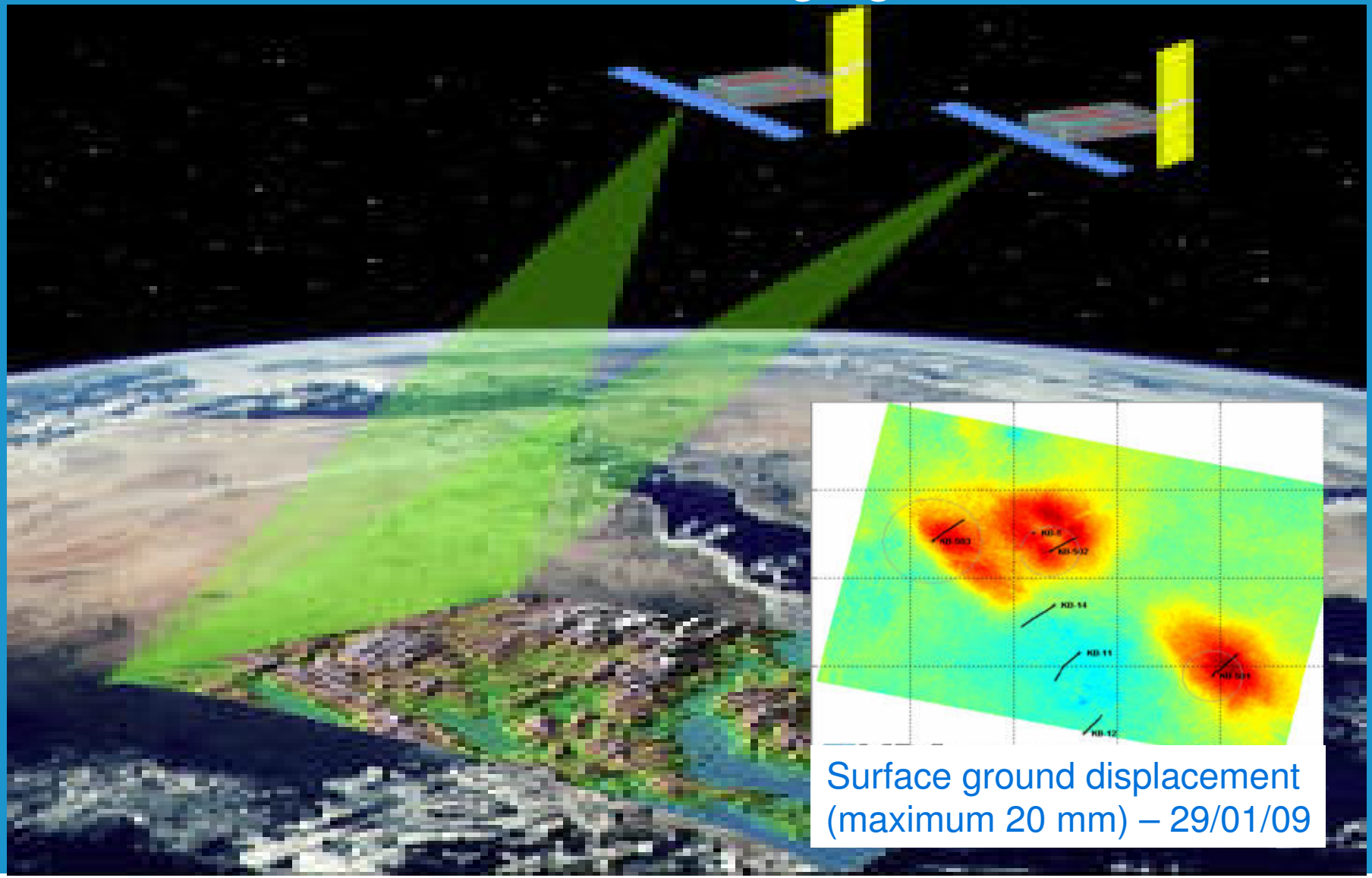
Modelling reservoir pressure and the observed associated surface geomechanical effects

- Input data
  - CO_2 injection data (3 wells)
  - Natural gas production data (5 wells)
  - Breakthrough observed at KB5
  - Mechanical data for the different layers
- Validation of a 3D reservoir model
- Coupled geomechanical modelling
  - Construction of an extended 3D geomodel
  - Geomechanical modelling using the 3D pressure field to load the structure



Extended geomodel verification

In Salah satellite surface imaging



Surface ground displacement (maximum 20 mm) – 29/01/09

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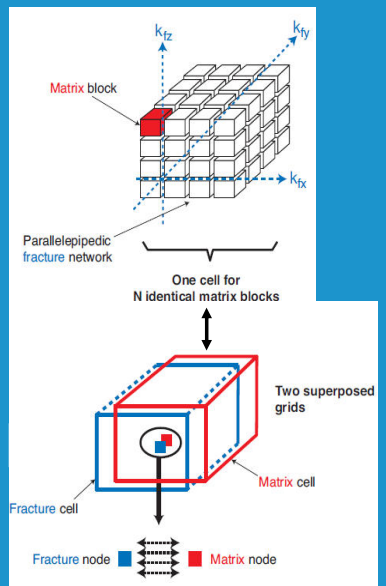
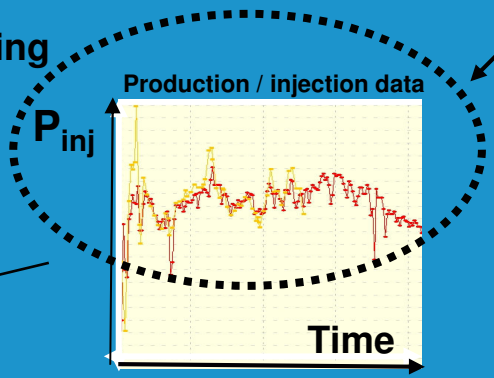
CO_2 storage in association with gas production: the In Salah case (CO_2ReMoVe project results – presented at GHGT10)

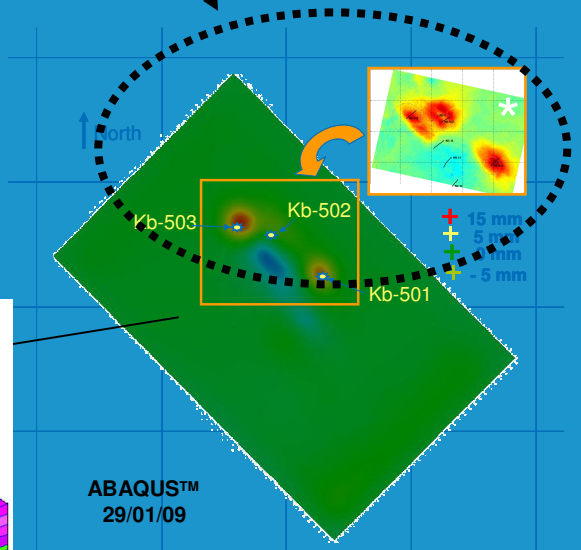
Dual media reservoir model



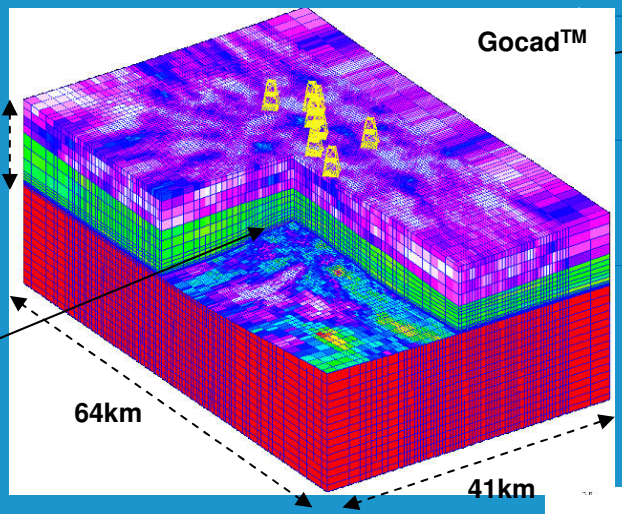
History matching



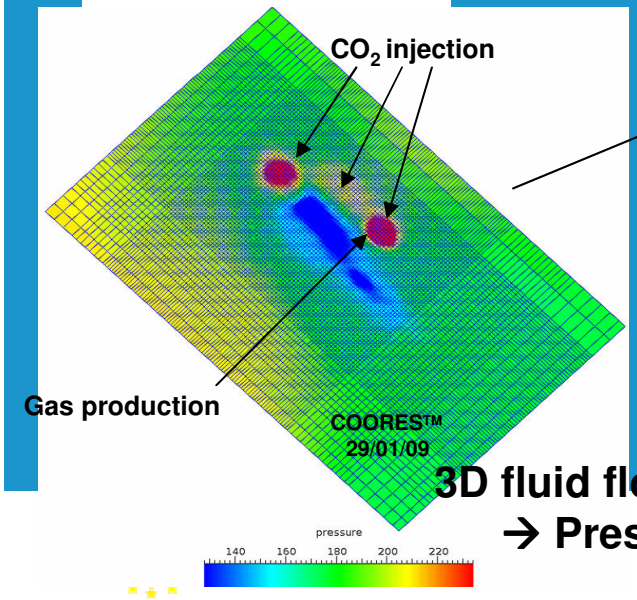
Measurements/simulations



Geomechanical modelling



Extended geomodel



3D fluid flow modelling
→ Pressure field

Satellite surface imaging used to validate modelling

Feedback from seismics, tiltmerters and µSeismicity to be considered soon

Conclusions on the In Salah example

- Research studies undertaken in the frame of the CO_2ReMoVe project benefit from:
  - pilot site data: illustrating from case to case a wide series of problems representative of the geological storage of CO_2
  - the complementary and concerted actions of the involved teams.

- Site characterization is a key point such as the availability of tools and methodologies able to manage the problem of reservoir heterogeneity, lack of data and uncertainties.

- Permanent objective (to reduce risks): improving the prediction reliability of the different scenarios by constraining simulation with observation.

Conclusions

- Long term PA aims at **predicting the long term fate of injected CO_2** within the storage complex. It is based on a **successful short term PA**.

- Satisfactory/reliable short term PA required **appropriate monitoring** (site dependant) to reduce discrepancies between prediction and observation (including remediation actions if required).

- **Research in association with site storage pilots is necessary** and to improve tools and methods especially for long term prediction of geochemical interactions (reactive transport).

Acknowledgements

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Thank you for your attention

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