# Integrated approach to $CO_2$-EOR and storage potential evaluation in an abandoned oil field in the Czech Republic

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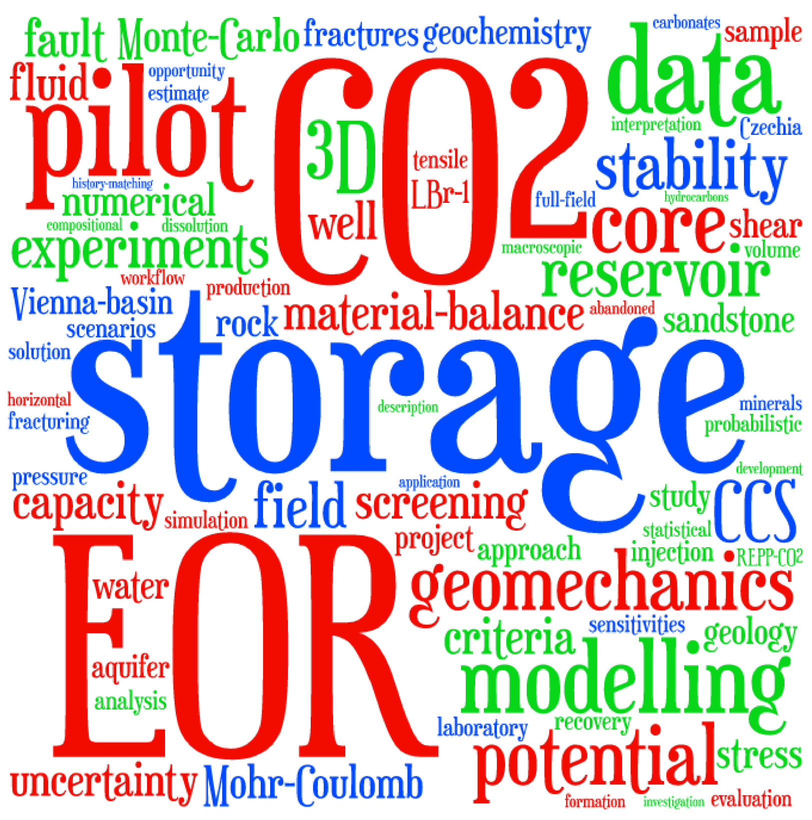


## Introduction

A small abandoned petroleum field in Vienna basin as a candidate for the $CO_2$-EOR and storage (CCUS) pilot

The field produced in 1950-1970's, the available reservoir data is limited and uncertain.

An integrated approach to evaluation of $CO_2$-EOR and storage potential was suggested based on available geological knowledge, core material and fluid samples (sometimes from the neighboring analog fields).

Material balance model, based on production history, was used as a first approximation for reservoir characterization, uncertainty analysis and screening of $CO_2$ storage capacity.

Laboratory investigations allowed to identify and reduce the uncertainties related to fluid properties, geochemistry and geomechanics. An approach was suggested to link core scale geomechanical experiments to the field scale, while addressing the uncertainty in a systematic way.

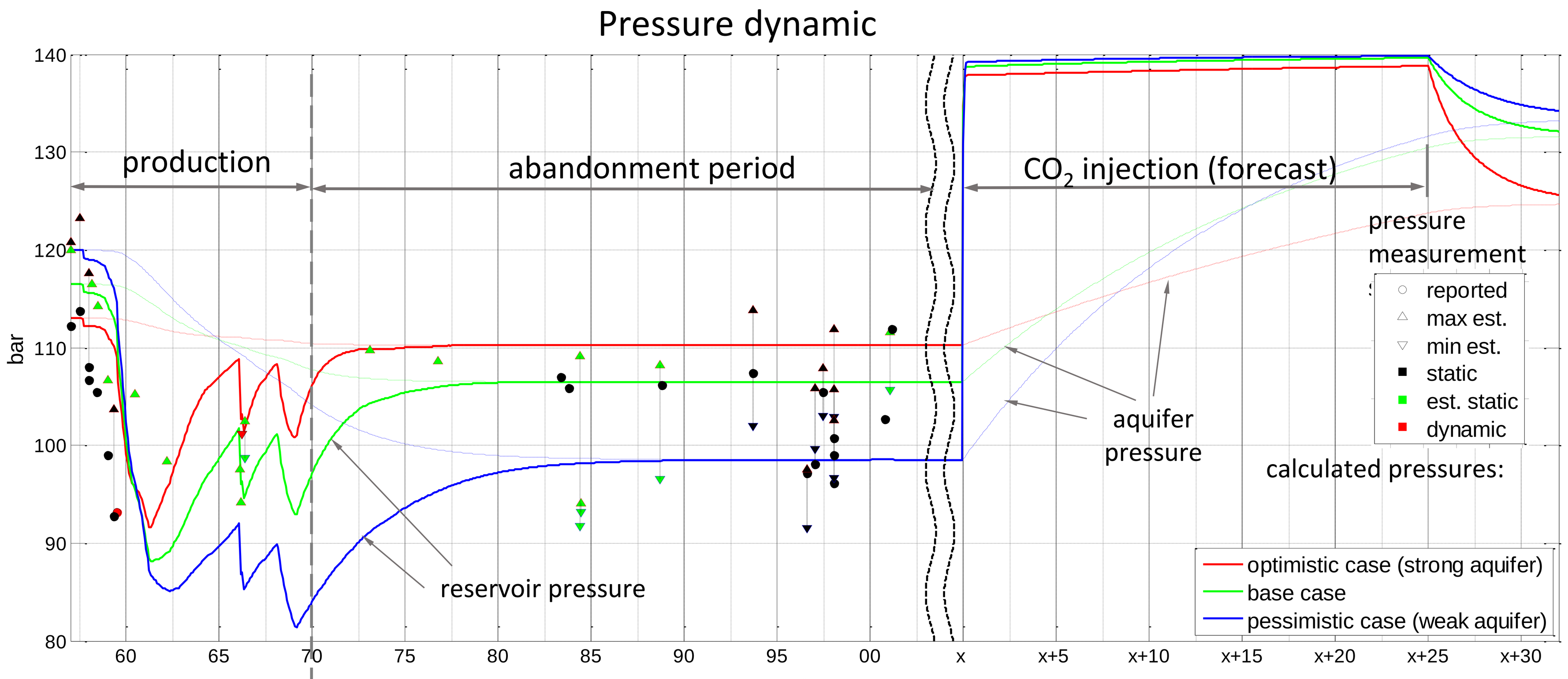
Input from the material balance study, geological modelling and experiments was used to build a numerical simulation model which was matched to available production history and used for evaluation of $CO_2$-EOR and storage potential.

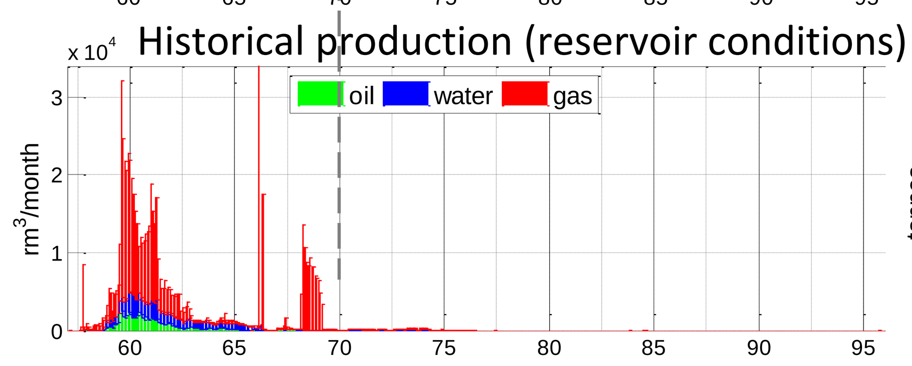
The poster focuses on key aspects of the approach and results obtained. Following details may be found in the paper:

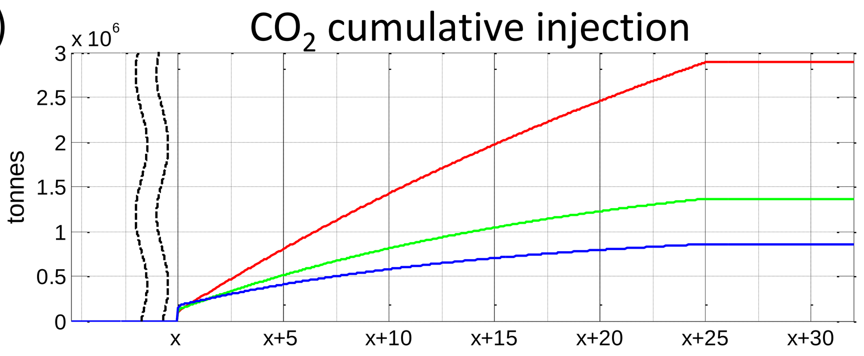
- Setup and use of the material balance model
- Estimation of ultimate $CO_2$ storage capacity (USC)
- Evaluation of Geomechanical Alterations with $CO_2$
- Description of the experiments
- Details on implementation and use of the geomechanical approach
- History matching of the numerical model
- Conclusions

## Material balance equation for reservoir screening

A material balance model is a robust and efficient tool for screening reservoir performance and evaluating storage capacity under limited data availability and uncertain reservoir conditions



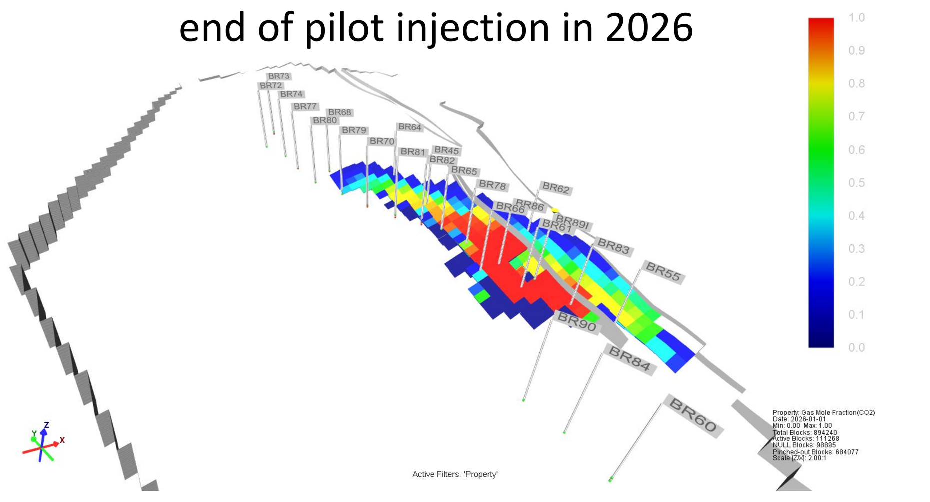

## Numerical modelling of $CO_2$ injection scenarios

**EOR case.** Two long horizontal producers are drilled along current gas-oil contact. Two corresponding horizontal $CO_2$ injectors along current water-oil contact set to maintain the pressure and replace the volumes produced. The maximum injection pressure is set to 30% above hydrostatic one. $CO_2$-EOR gives approximately 20% additional oil recovery.

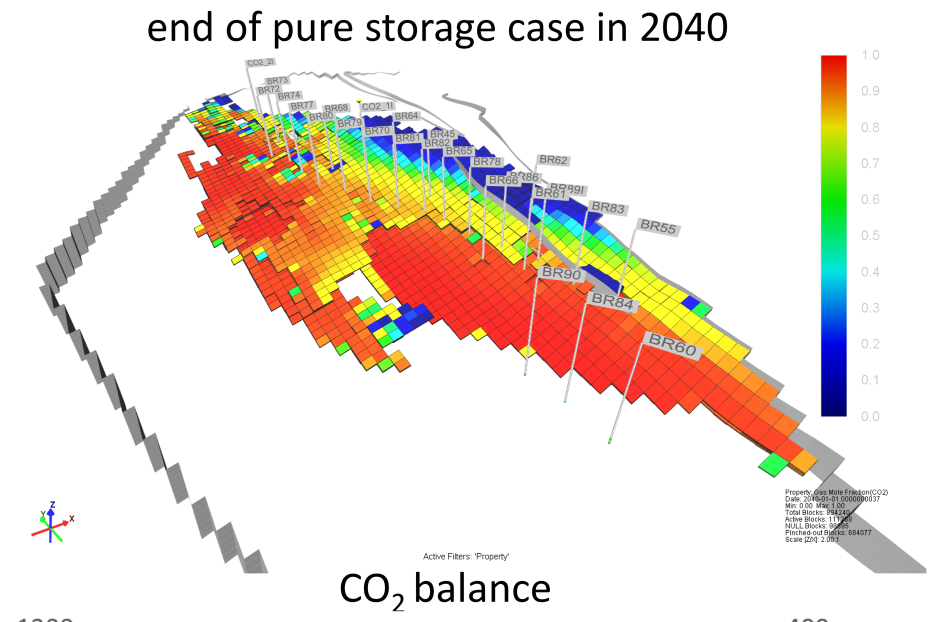
**Storage case** starts with a pilot $CO_2$ injection from 2020 to 2026 through a single vertical well. Afterwards, the two horizontal injectors are drilled and massive $CO_2$ storage continues until 2040.

**Combined case.** Following the $CO_2$ pilot injection in 2020-2026, the two horizontal producers are drilled, and oil is produced for three years (2026-2029) recovering app. 50% of additional oil compared to EOR case. Subsequently, massive $CO_2$ storage continues until 2040 , utilizing the existing horizontal wells

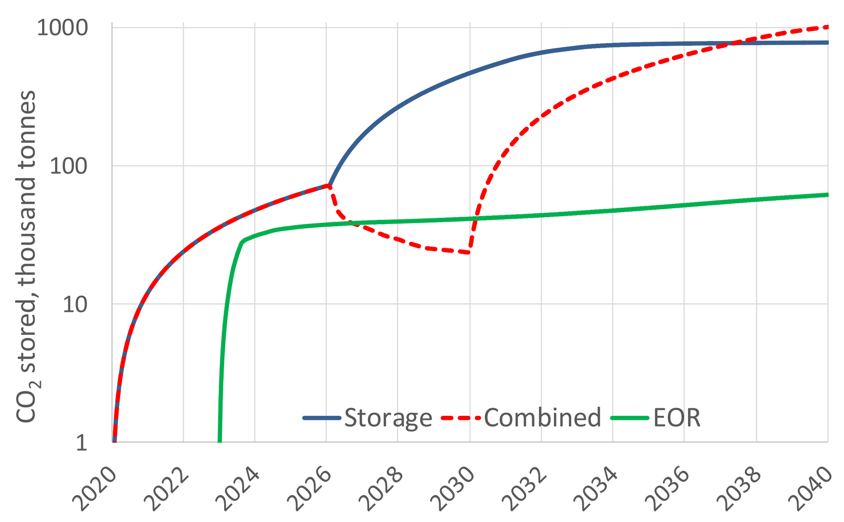
$CO_2$ gas mole fraction at the end of pilot injection in 2026



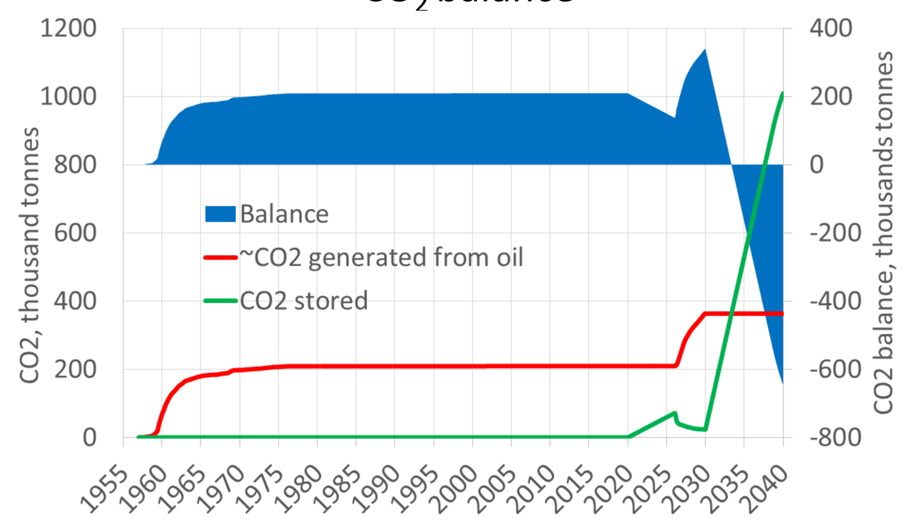
$CO_2$ gas mole fraction at the end of pure storage case in 2040



Cumulative $CO_2$ storage for scenarios




$CO_2$ balance




**Combined case** results in negative carbon dioxide balance of the total oil production!

## Evaluation of fault reactivation potential under uncertainty

### Input

In-situ stress and geomechanical parameters:

- Analysis of laboratory data
- In-situ stress magnitude and directions
- Fault geometry

Probability distributions to describe uncertainties

### Simulation approach

Mohr-Coulomb failure criterion as basis

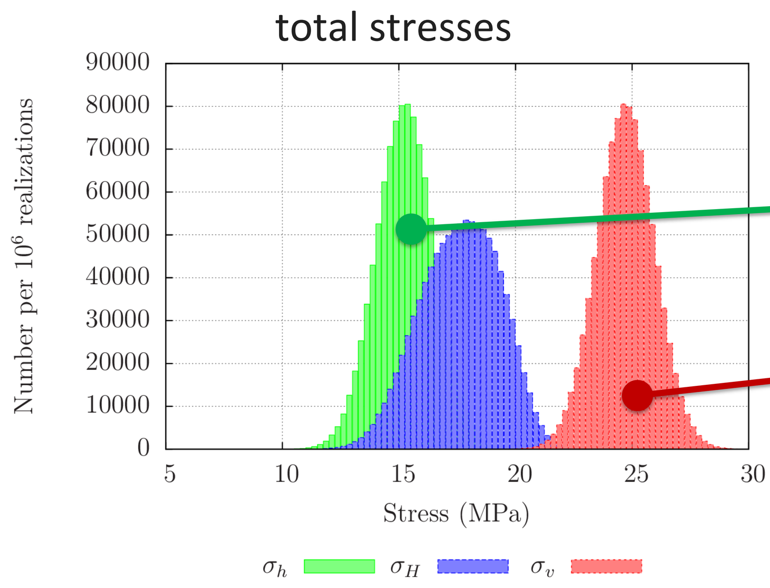
Monte Carlo simulations within uncertainty

### Results

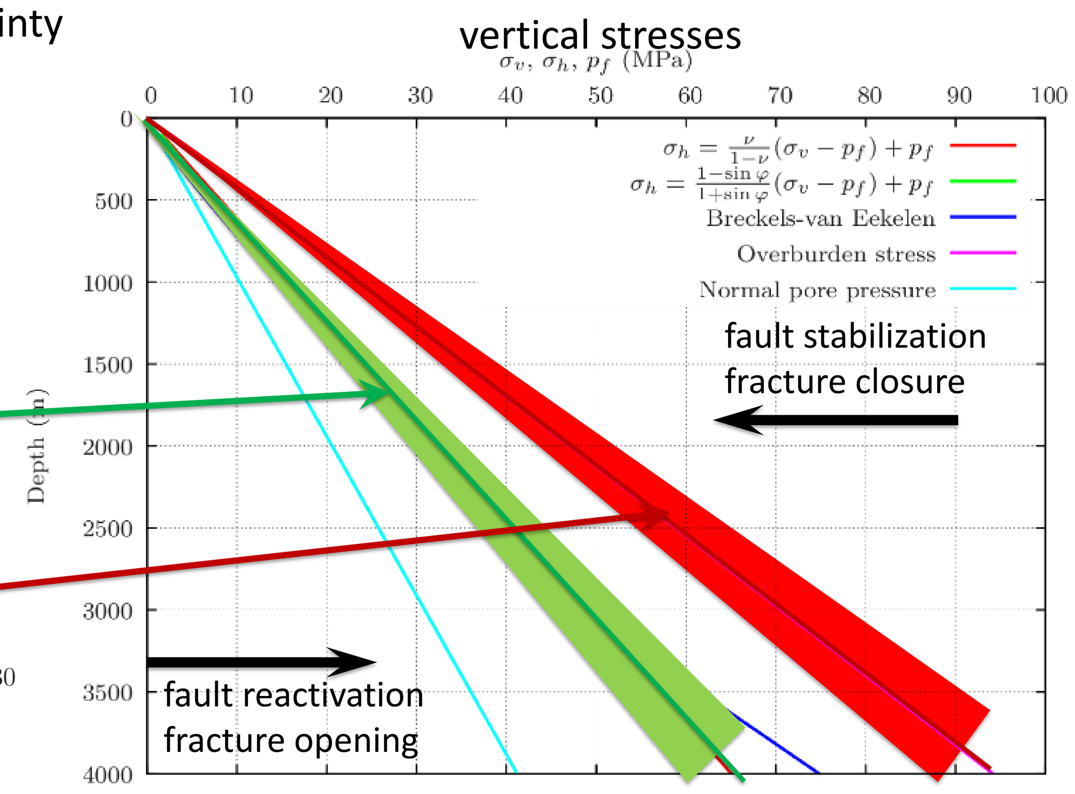
Probability of fault reactivation (unstable/stable realizations in Monte-Carlo runs)

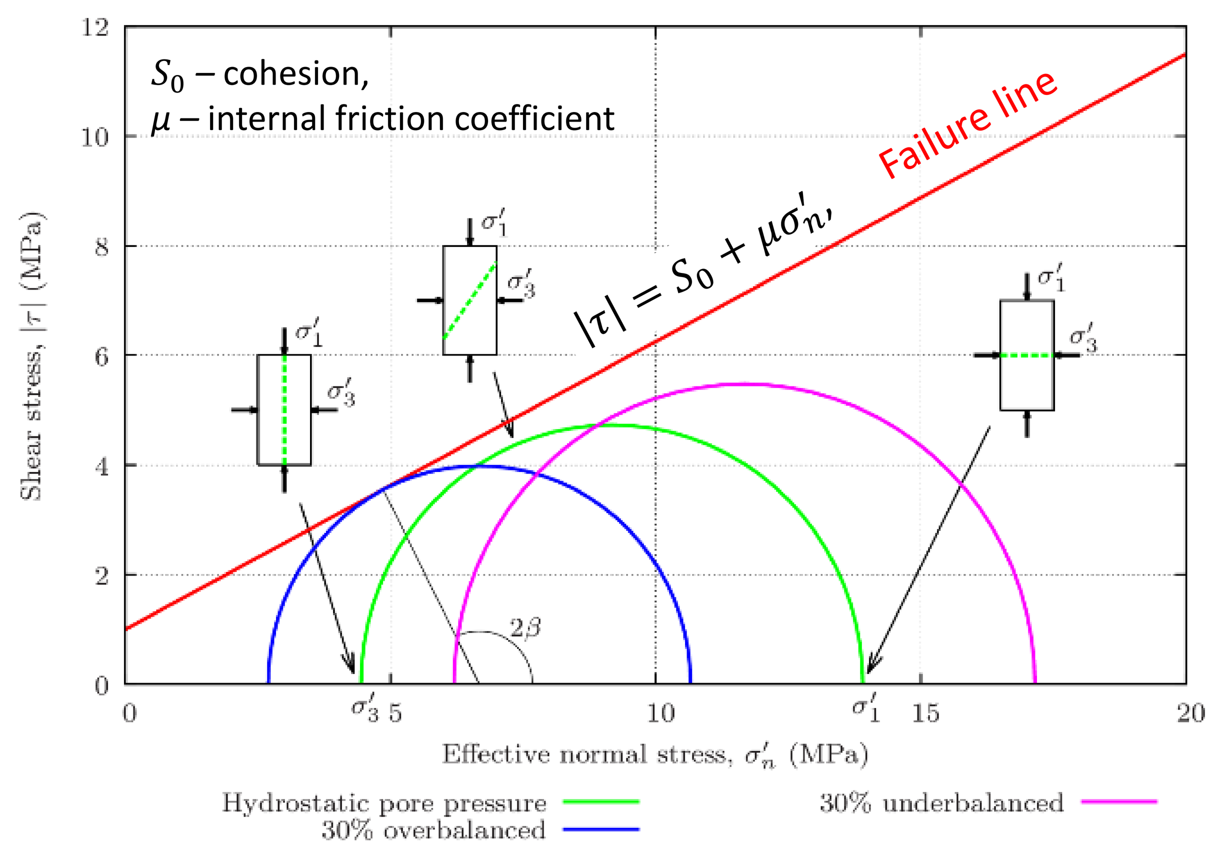
Induced fracturing probability (exceeding minimum horizontal stress + tensile strength)

Probability distributions for in-situ total stresses




Uncertainties with in-situ minimum horizontal and vertical stresses



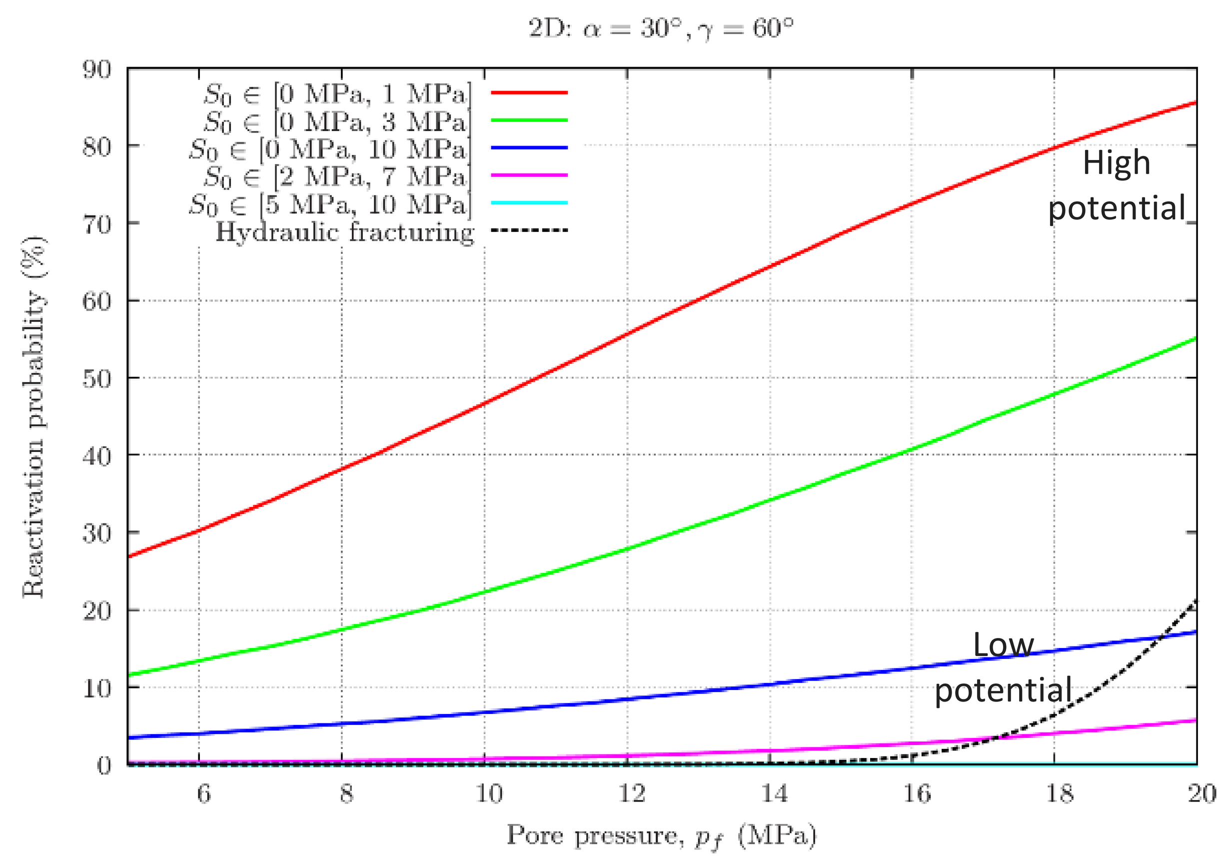




$CO_2$ injection changes field stresses. This may cause fault re-activation.

Monte Carlo simulations of fault stability based on probability distributions and Mohr-Coulomb failure criterion are used to evaluate risks of fault re-activation.

Presented approach allowed to assess fault re-activation potential covering the uncertainty in geomechanical parameters due to limited core availability and field measurements.

$CO_2$ injection scenarios were designed to minimize the fault re-activation risks.





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