Simulation of coalbed methane flows,
hydro-mechanical modelling in a particular fractured reservoir

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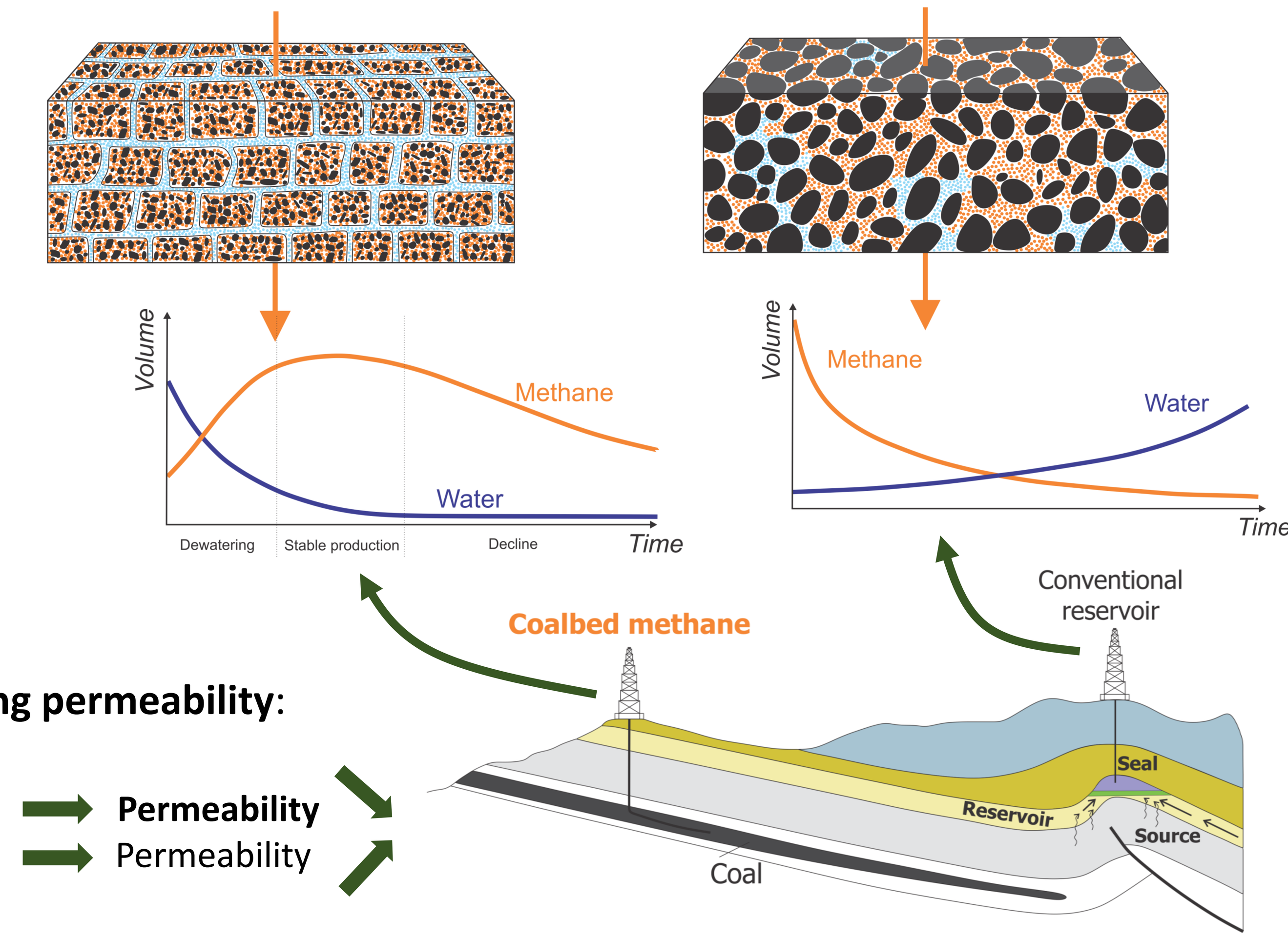
Introduction

Coalbed Methane (CBM)
=
Unconventional resource

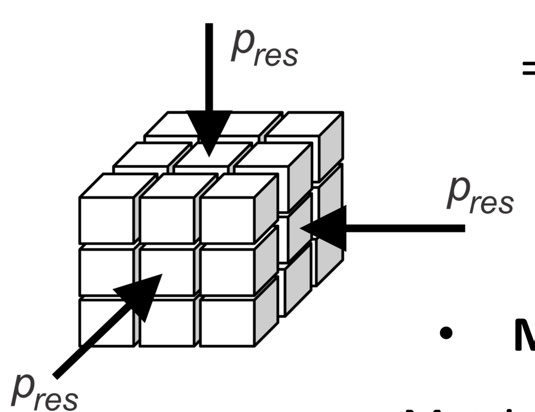
Unconventional modelling



In particular, **2 remarkable phenomena affecting permeability**:

- **Pressure depletion** → Reservoir compaction → **Permeability** ↘
- **Gas desorption** → Matrix shrinkage → Permeability ↗

Model



- **Adsorbed gas** content = *f(Reservoir pressure)*

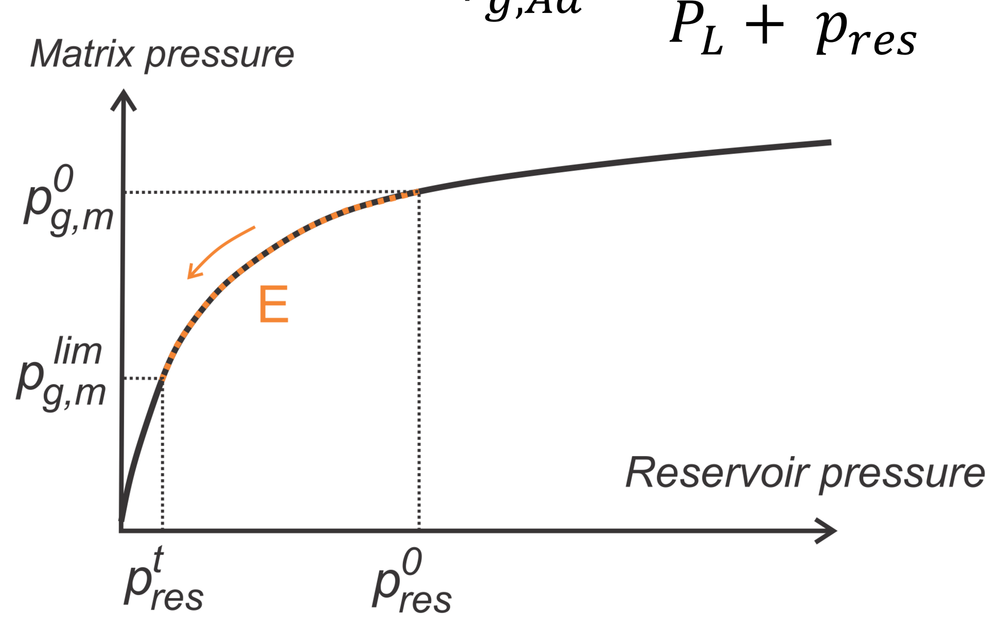
Langmuir's law to fit experimental data

$$V_{g,Ad} = \frac{V_L . p_{res}}{P_L + p_{res}}$$

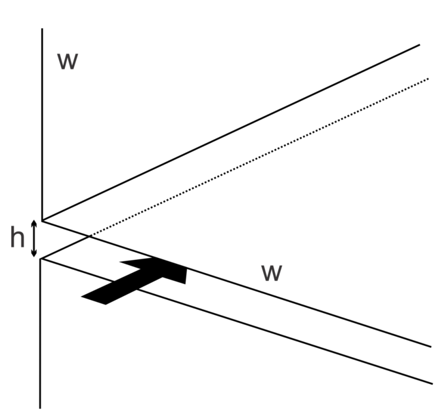
- **Mass Exchange**

Matrix → Fractures

$$E = \tau\left(p_{g,m} - p_{g,m}^{lim}\right)$$



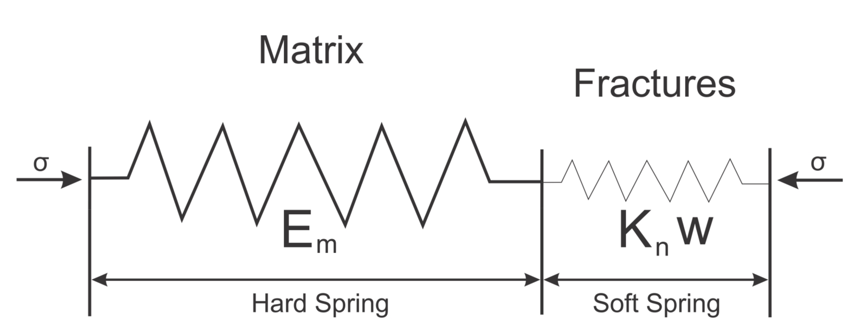
- **Fluid flow** into natural **fracture** network



$$k = \frac{h^3}{12w}$$

- **Fracture aperture evolution** with **stress** state

$$\dot{h}_x = \frac{\sigma'_{xx}}{K_{n_x}}$$

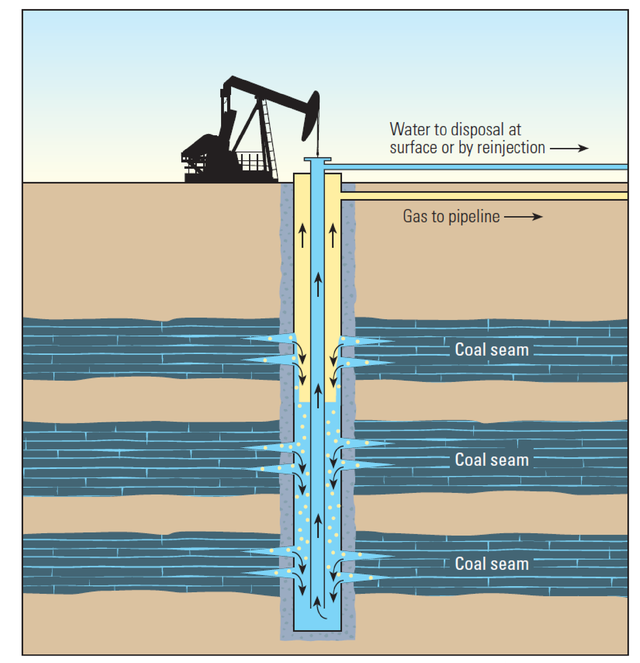


- **Equivalent medium**

- **Stress** state influenced by:
  - Fluid pressure:
    Effective stress concept
  - Gas desorption:
    Sorption-induced volumetric strain

$$\varepsilon_{v_s} = \beta_\varepsilon . V_{g,Ad}$$

Results



From (Al-Jubori 2009)

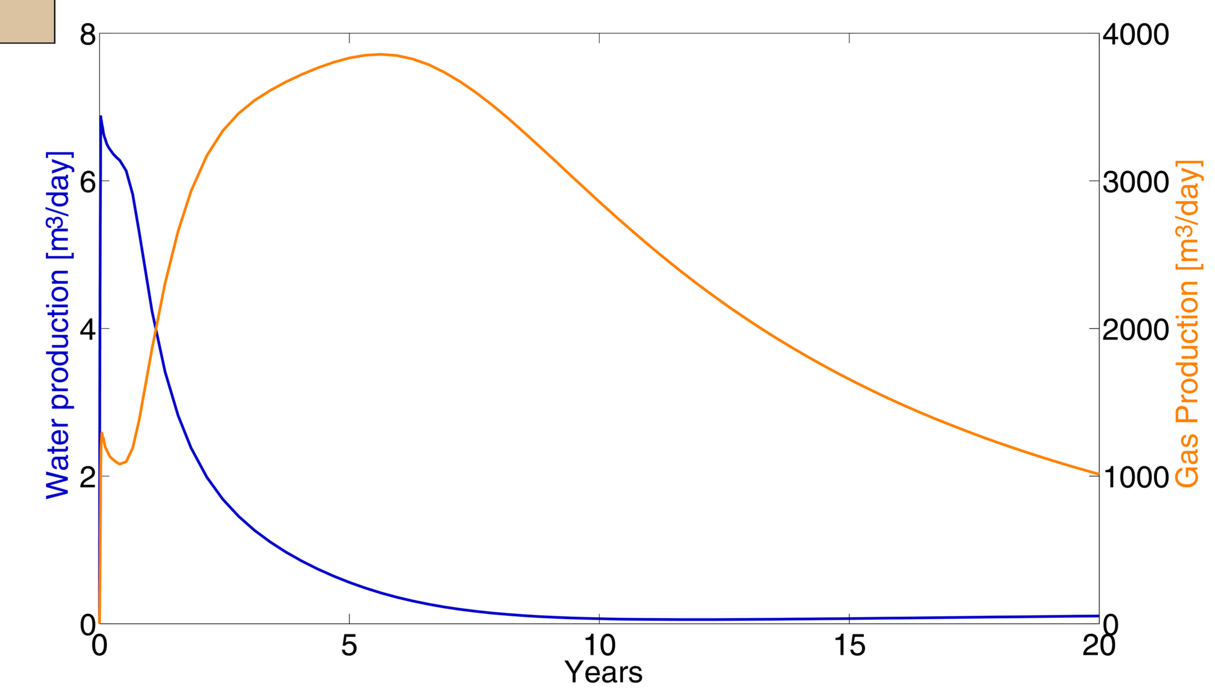
One well **2D axisymmetric**
5-meter-thick coal seam

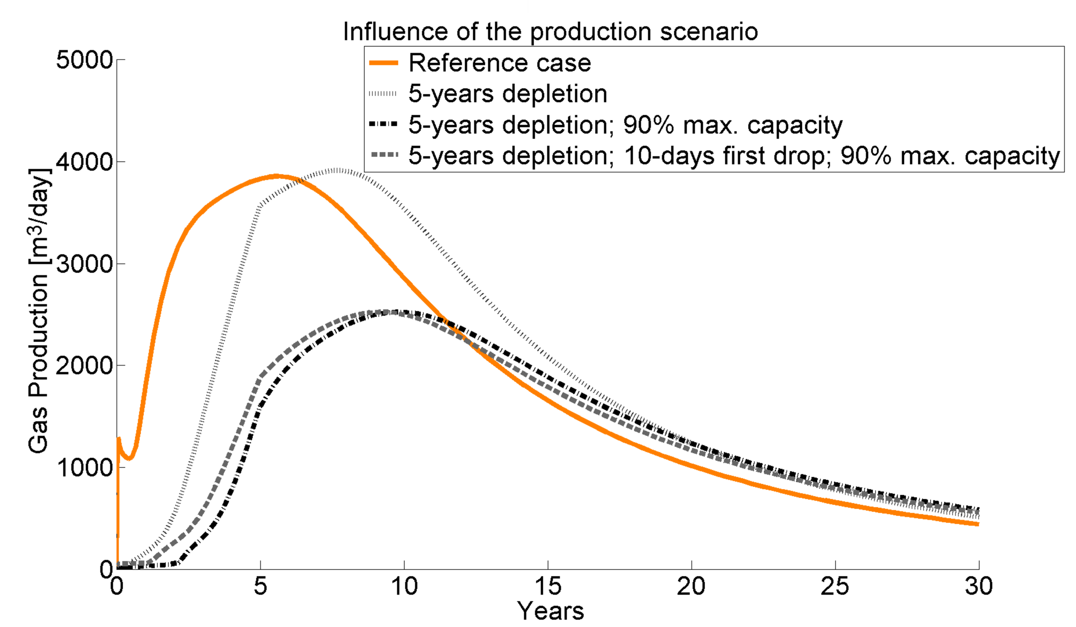
Initial conditions:
The reservoir is **water saturated** with hydrostatic pressure maintaining gas adsorbed in the matrix

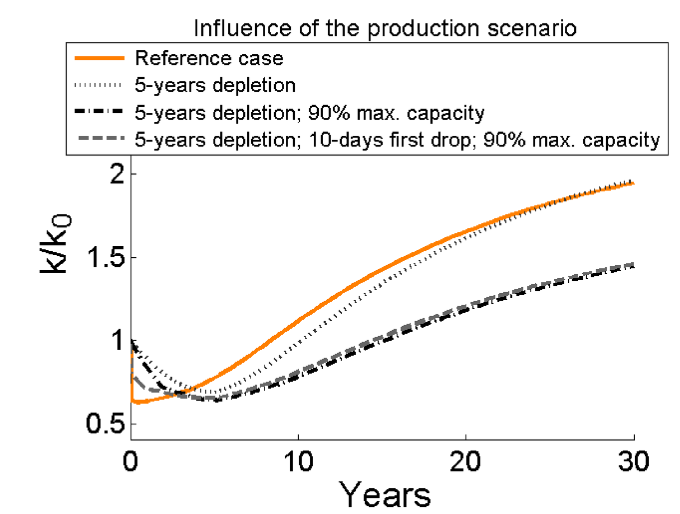
Loading:
Fast **pressure drop** at the well

Production profiles:
Gas production peaks after water

Reference case

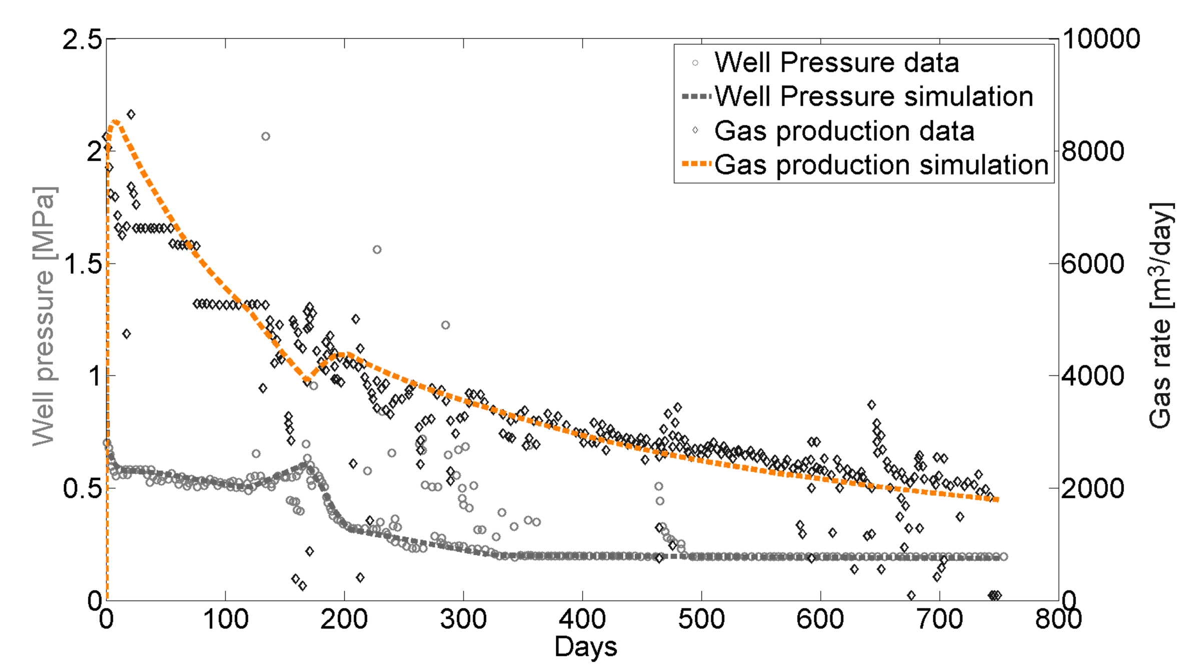






Production history **matching exercise**

Horseshoe Canyon coals
Dry reservoir
(Gerami, 2007)



Conclusions

HM couplings are a **critical issue** in CBM recovery:
Permeability is directly dependent on **fracture aperture**, which evolves with the **stress state**.

Permeability is first decreased due to the **pressure drop**.

Initial permeability may be recovered thanks to the matrix **shrinkage**.

These **phenomena** are **taken into account** with a macroscopic model enriched with microscale considerations.

Perspectives: multiscale model

Acknowledgements

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