Hydro-mechanical modelling of coalbed methane recovery

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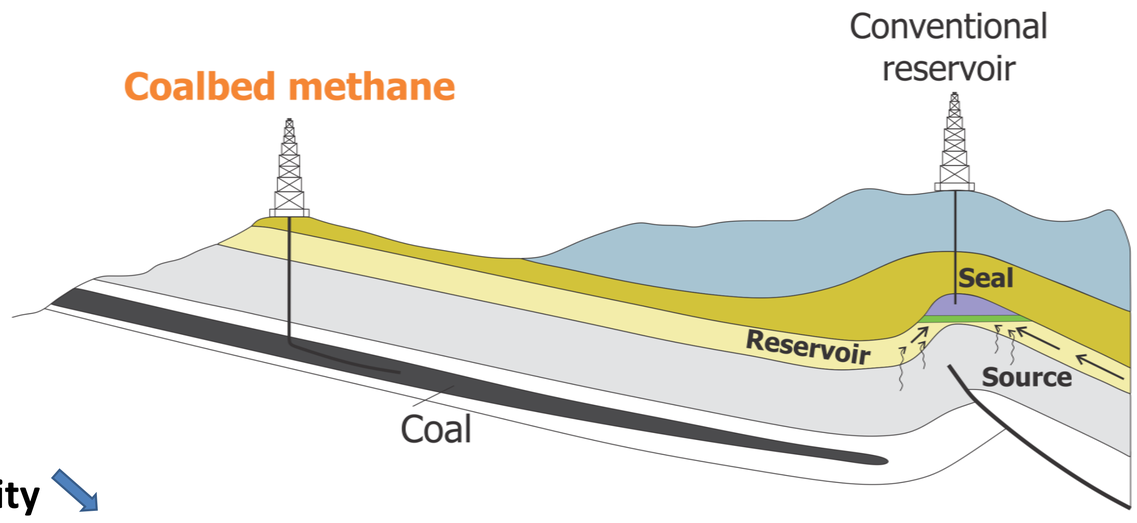
1. Context

Coalbed Methane (CBM)
=
Unconventional resource

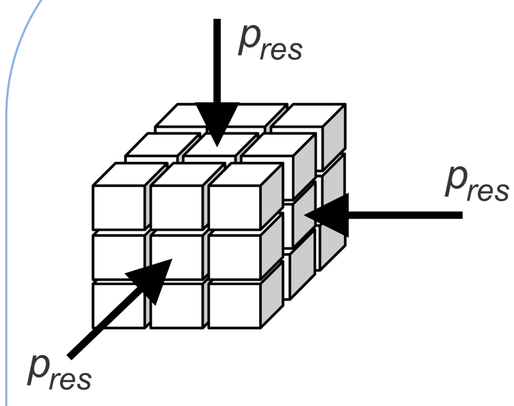
→ Unconventional modelling



In particular, 2 remarkable phenomena affecting permeability:

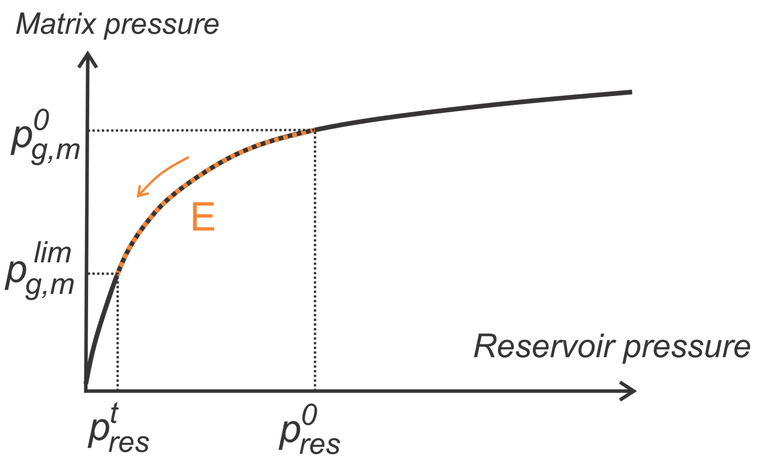
- Pressure **depletion** → Reservoir **compaction** → **Permeability** ↘
- Gas **desorption** → Matrix **shrinkage** → Permeability ↗

2. Model



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

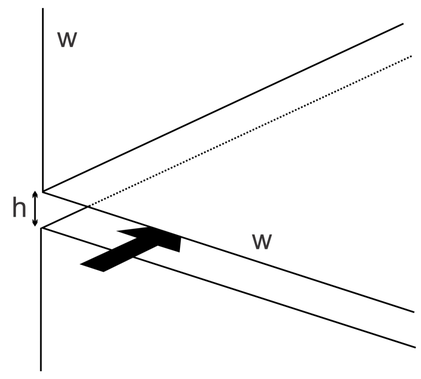
Langmuir's law to fit experimental data



- **Mass Exchange**

Matrix → Fractures

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



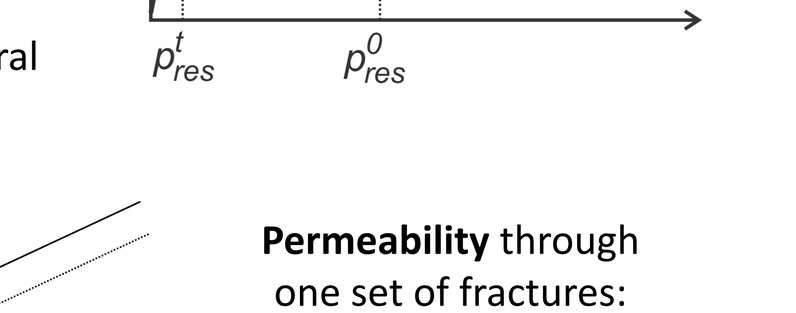
Permeability through one set of fractures:

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

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

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

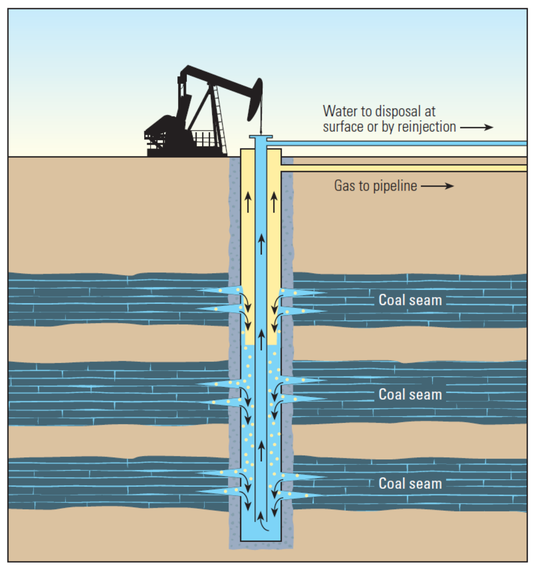
Equivalent medium



Stress state influenced by:

- Fluid pressure:
  Effective stress concept
- Gas desorption:
  Shrinkage proportional to mass exchange rate

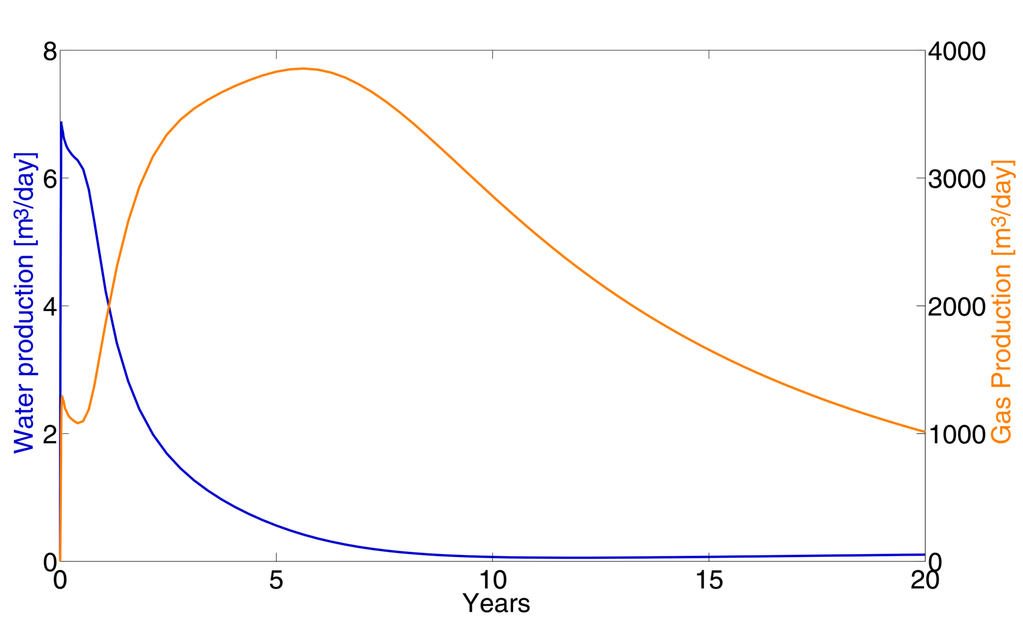
3. Production simulation



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

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

Production curves:
Gas production peaks after water



4. 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

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