

The Impact of Geologic Heterogeneity on CO₂ Injection with Simultaneous Brine Extraction and Economic Uncertainty for Large-Scale CO₂ Sequestration

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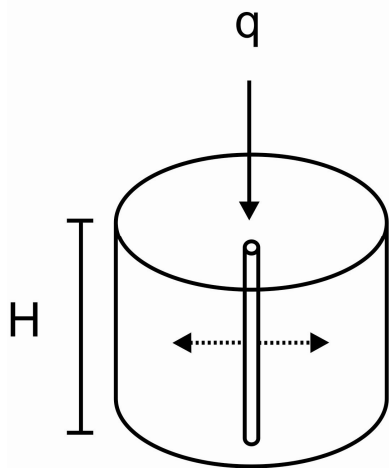
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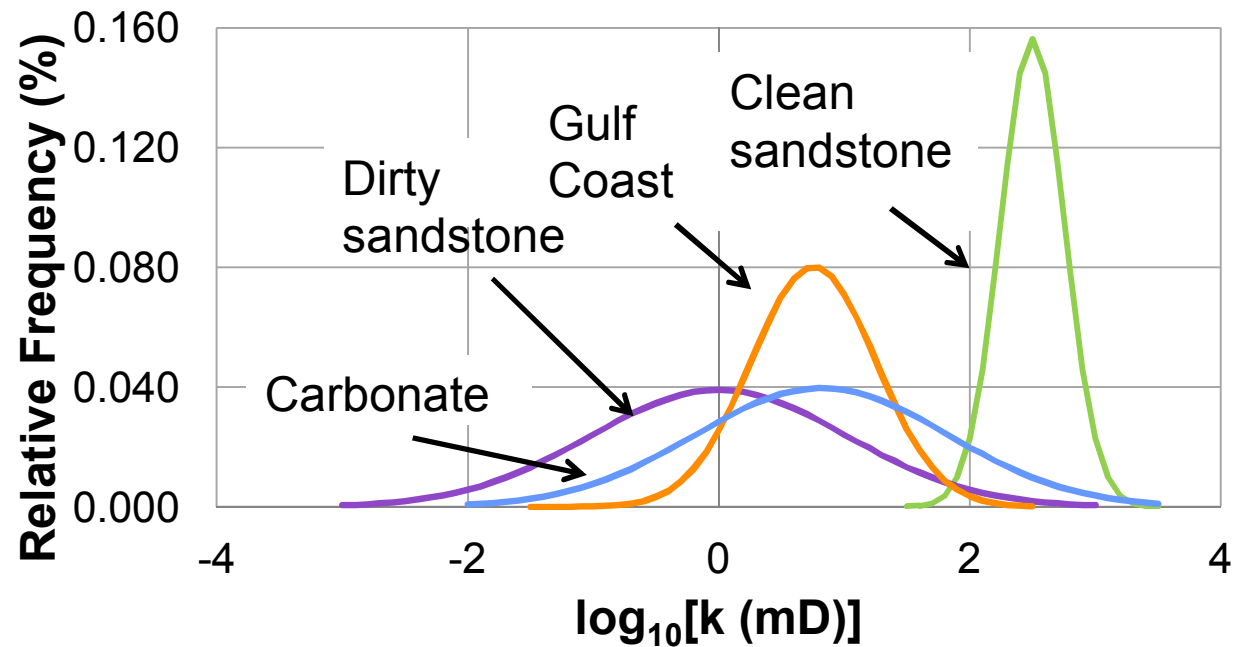
CO₂ Injectivity and Large Scale Economic and Storage Assessment

$$I \equiv \frac{q}{\Delta P}$$



Reservoir volume

Radial flow from the well

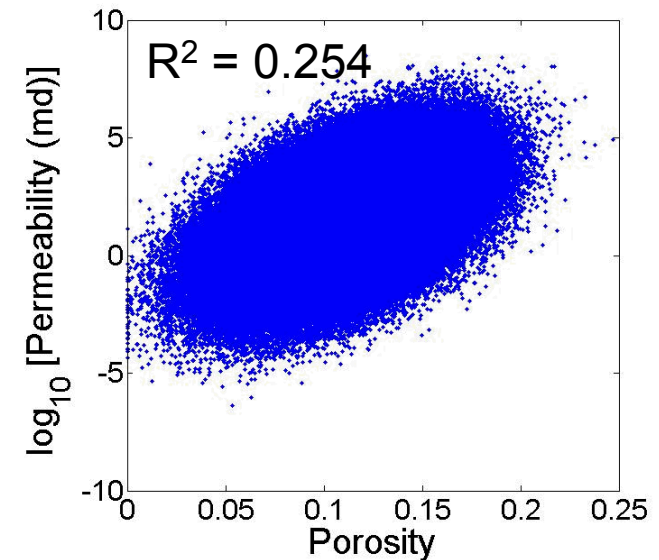


(Kobos et al., 2011)

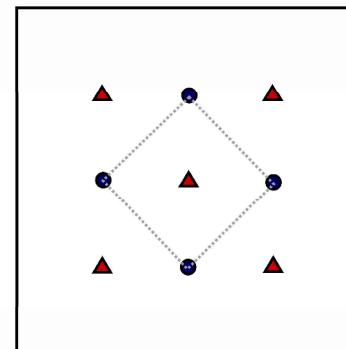
Examples: Eccles, 2011; Keating et al., 2011; Cinar et al., 2008; Stauffer et al., 2009; Zakrisson et al., 2008; and many others

Digging into Common Assumptions

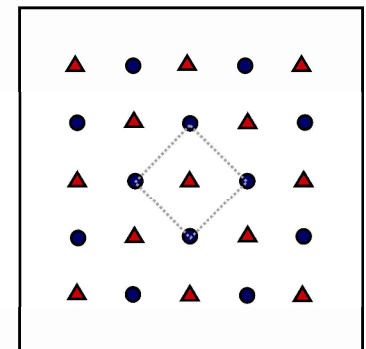
1. How does correlation between permeability and porosity affect injectivity?
2. How different in terms of injection rates are the homogeneous versus heterogeneous cases?
3. How does heterogeneity impact well numbers and hence costs?



- ▲ CO₂ injector
- Brine extractor



16 km



16 km

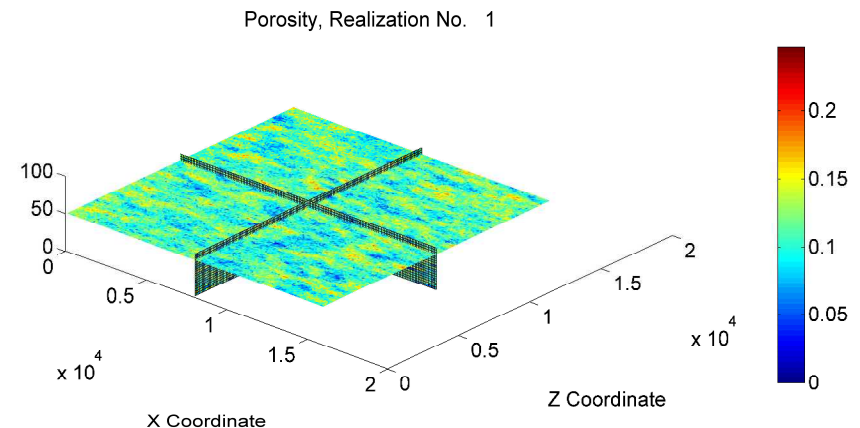
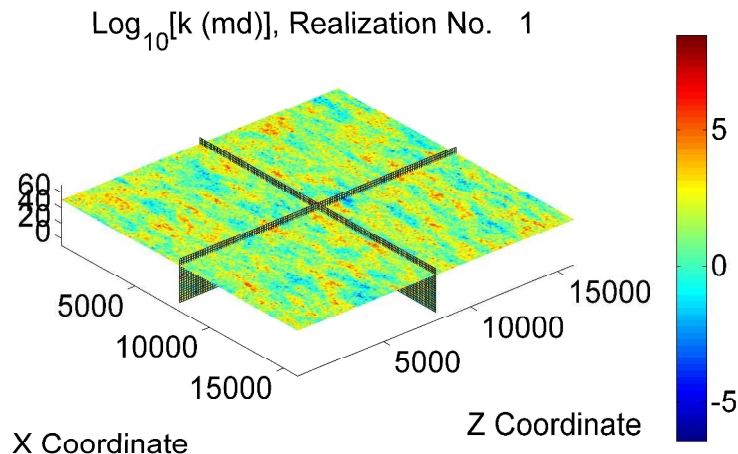
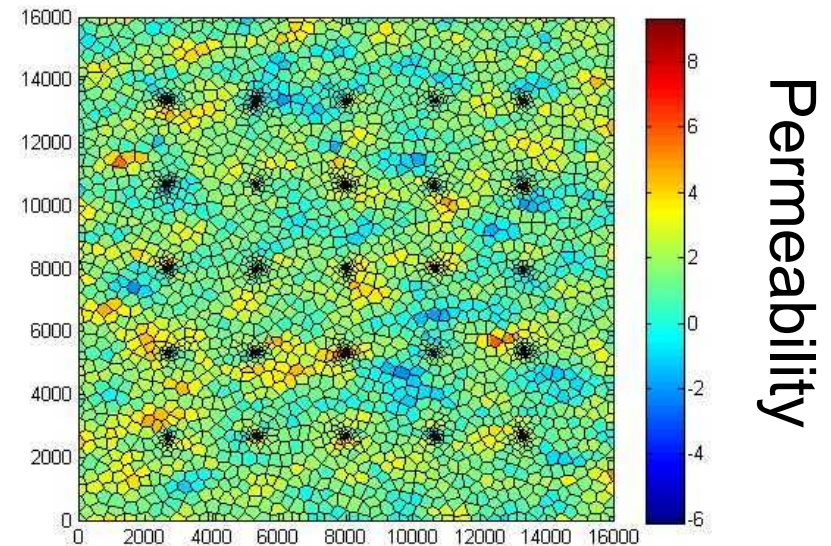
Methods

2. Multiphase Flow: TOUGH2-ECO2N

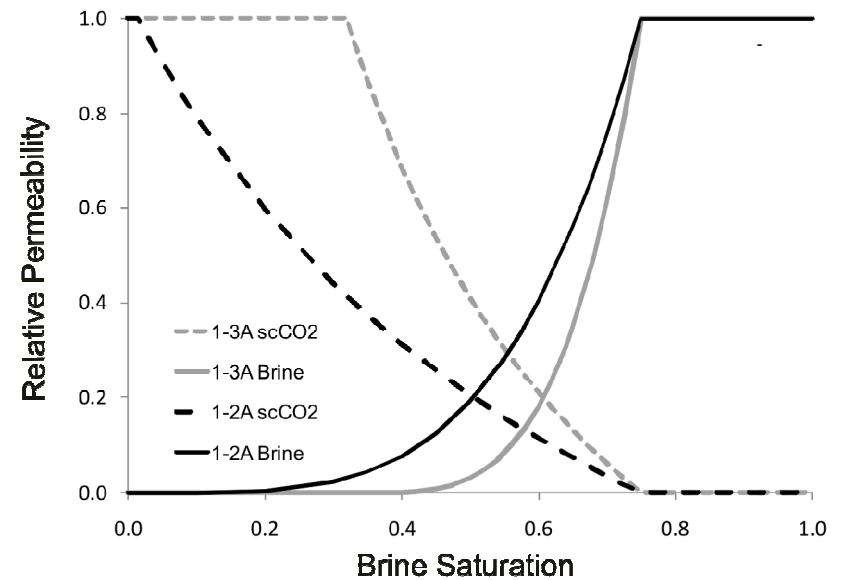
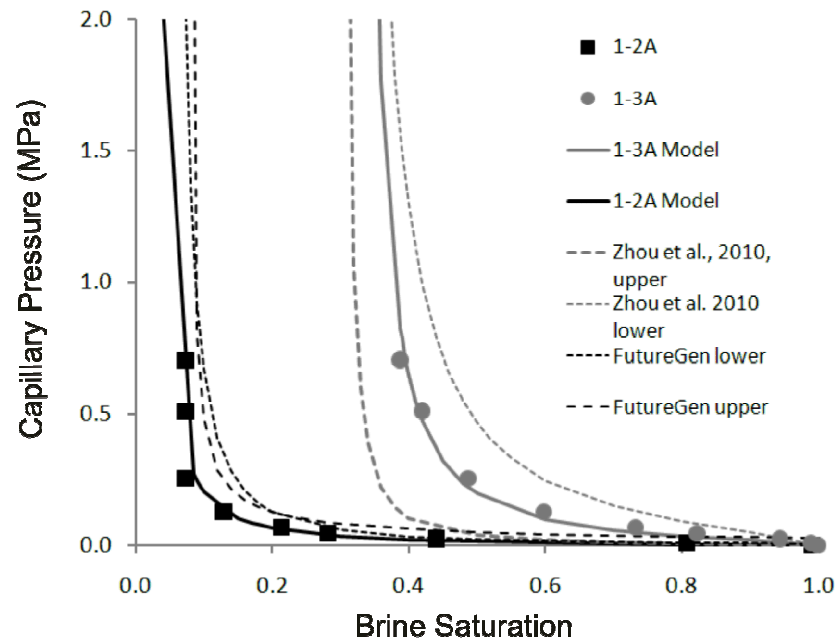
1. Geostatistics:

Coregionalization and SGSIM
(Rautman and McKenna,
1997; Deutsch and Journel
1992)

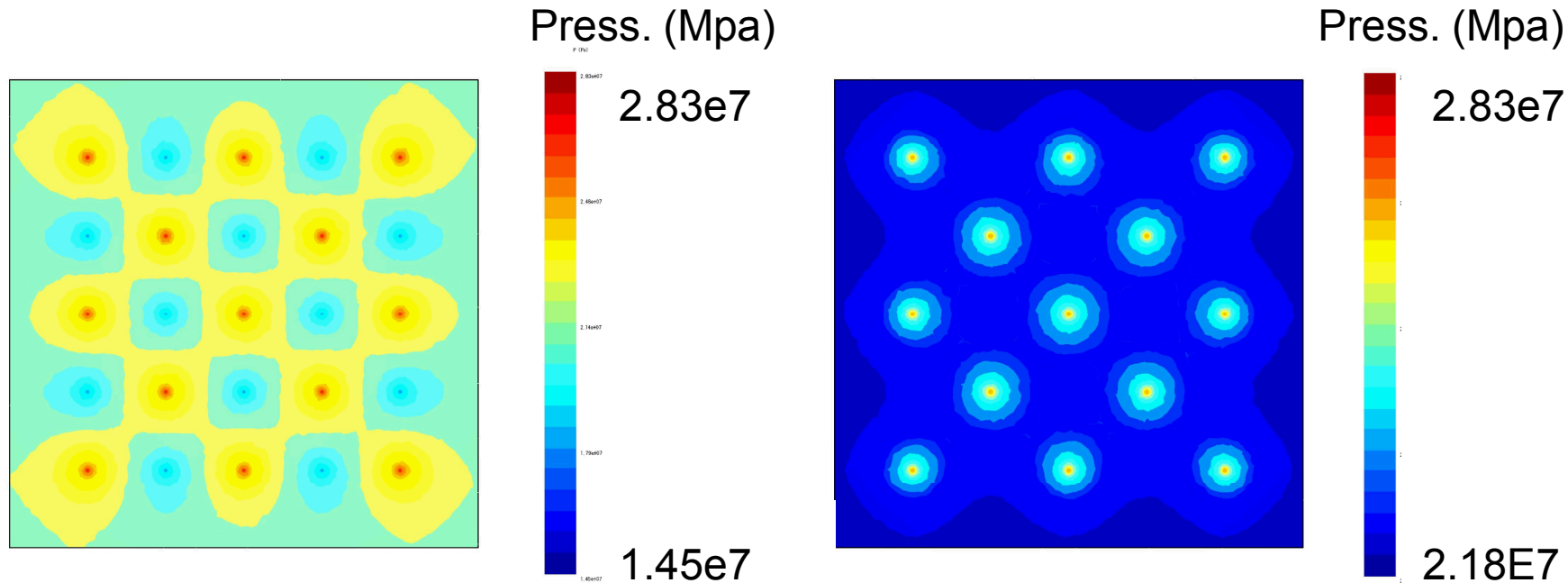
$$r^2 = \underline{0.9} \text{ or } \underline{0.254}$$



Relative Permeability & Capillary Pressure



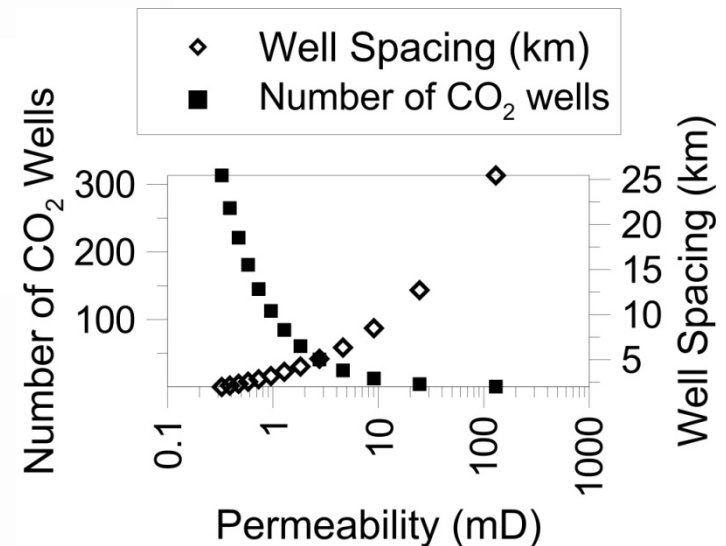
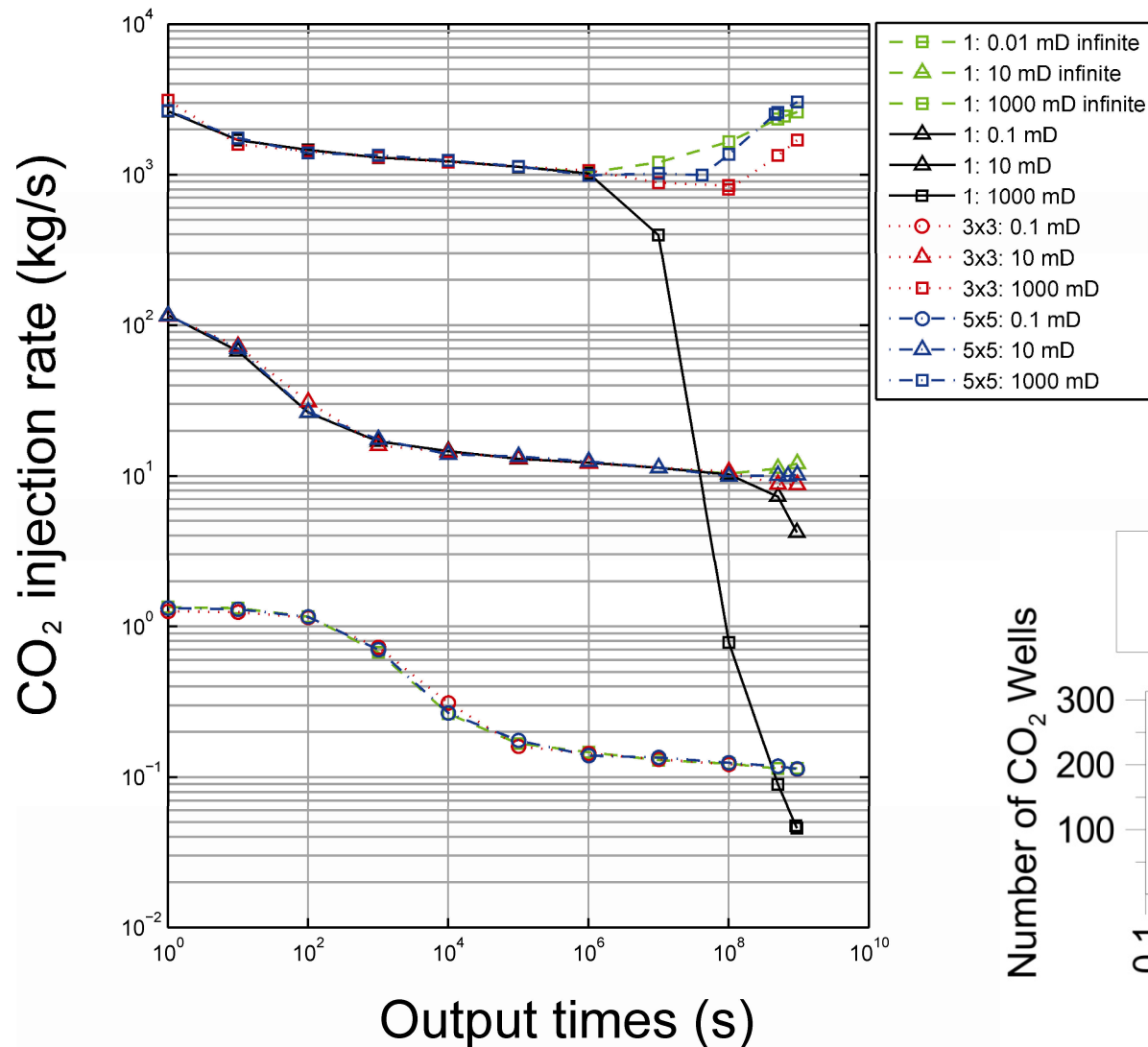
Methods: Base Cases



Time = 57 days

- Permeability = 29.7 md; porosity = 11.1 % (Finley, 2005)
- CO₂ injection with or without brine extraction
- Maximize flow rates: constant pressure at wells
- Closed reservoir
- Homogenous and heterogeneous cases

Results – Injections Rates



Conclusions

Brine extraction lengthens time period of high injectivity in closed reservoirs

Brine extraction, however, may be limited by breakthrough for higher permeability cases

Heterogeneity provides a mix of high and low injectivity wells, thus making simple analytical solutions difficult

Acknowledgements

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