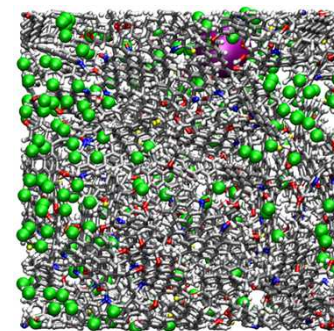
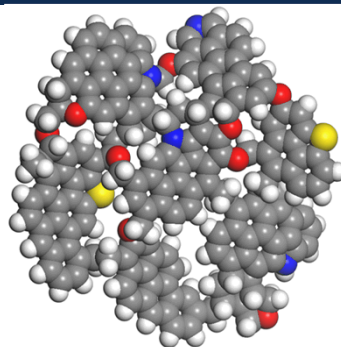


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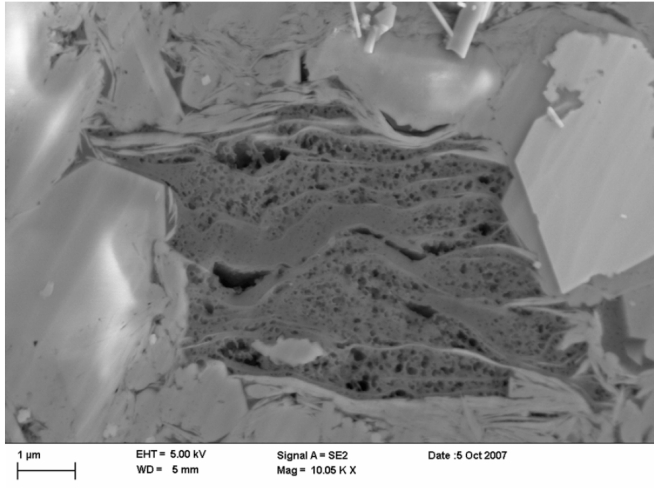
Nanostructural control of methane and carbon dioxide transport and adsorption in kerogen

Tuan Anh Ho¹, Louise Criscenti¹, Yifeng Wang¹, Yucel Akkutlu²

¹Sandia National Laboratories, Albuquerque, New Mexico, United States.

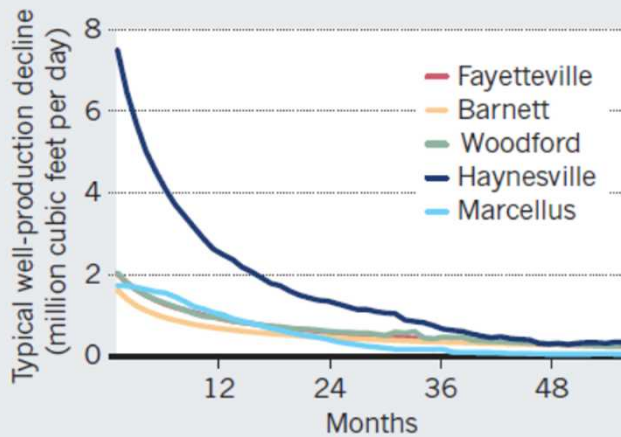
²Texas A&M, College Station, Texas, United States.

Kerogen

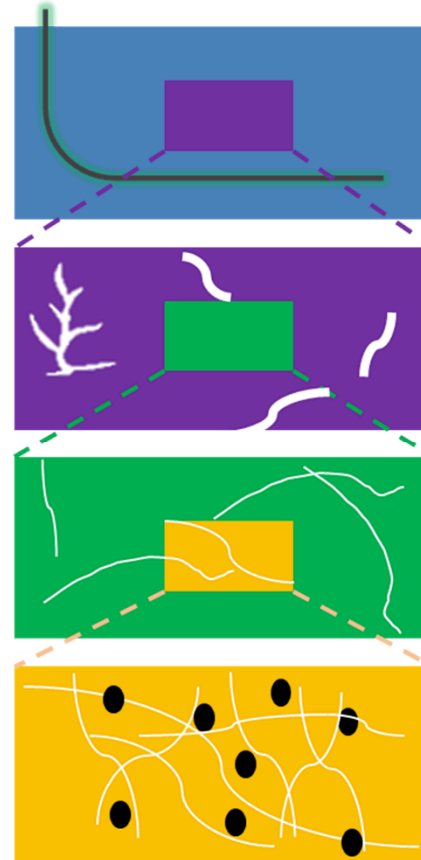


SPE 124253 (2009)

TOP FIVE SHALE PLAYS



Nature 494, 307 (2013)



JCPT 46, 55 -61 (2007)

Macroscale:
gas flow to
the wellbore

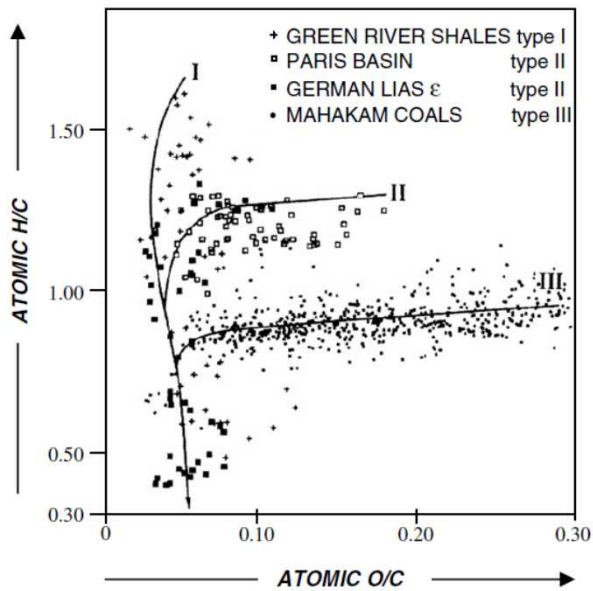
Mesoscale:
micro-fractures
network

Microscale:
nanopores
network

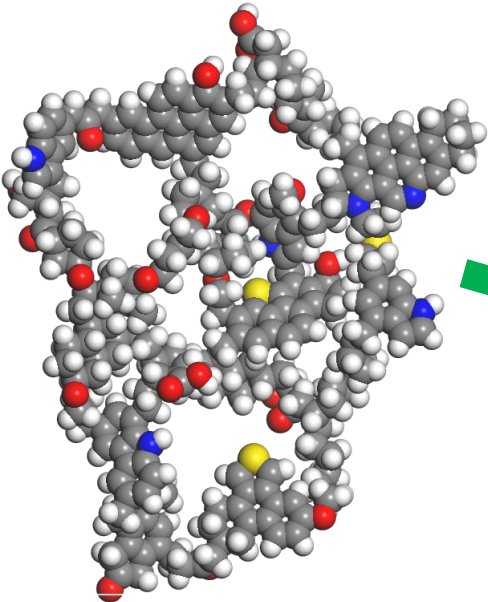
Nanoscale/Sub-nanoscale:
Gas diffusion from
kerogen/clay porous
structure to nanopores.

Kerogen

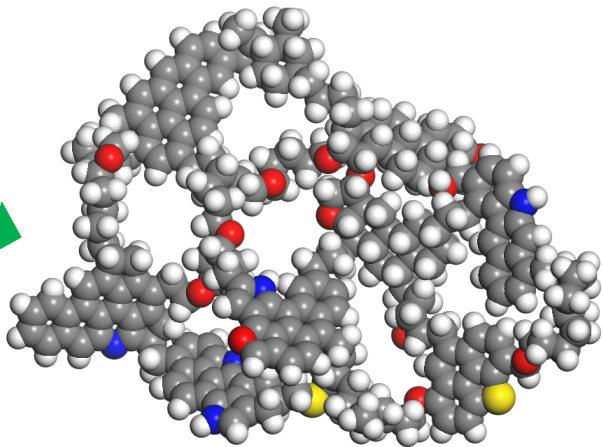
Van Krevelen diagram



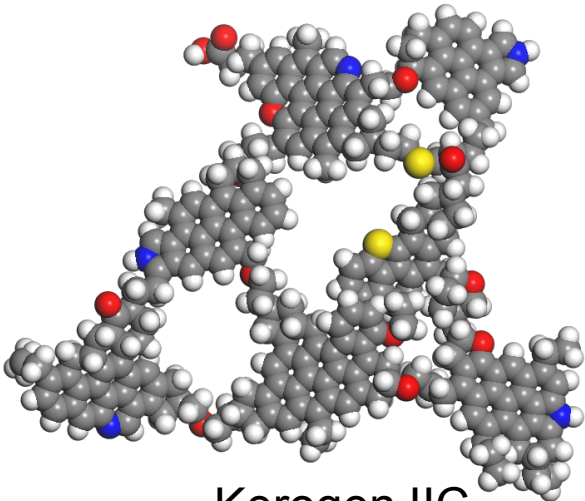
Organic Geochemistry 38, 719-833 (2007)



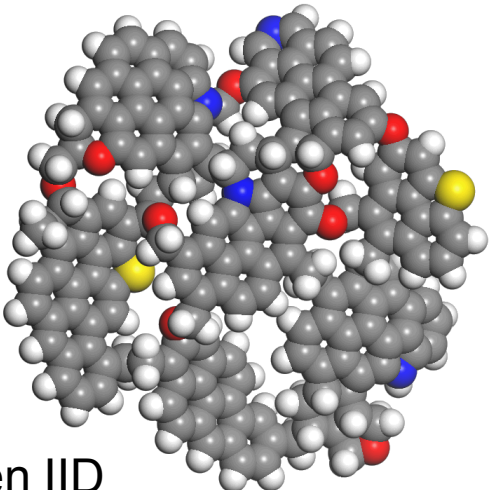
Kerogen IIA



Kerogen IIB



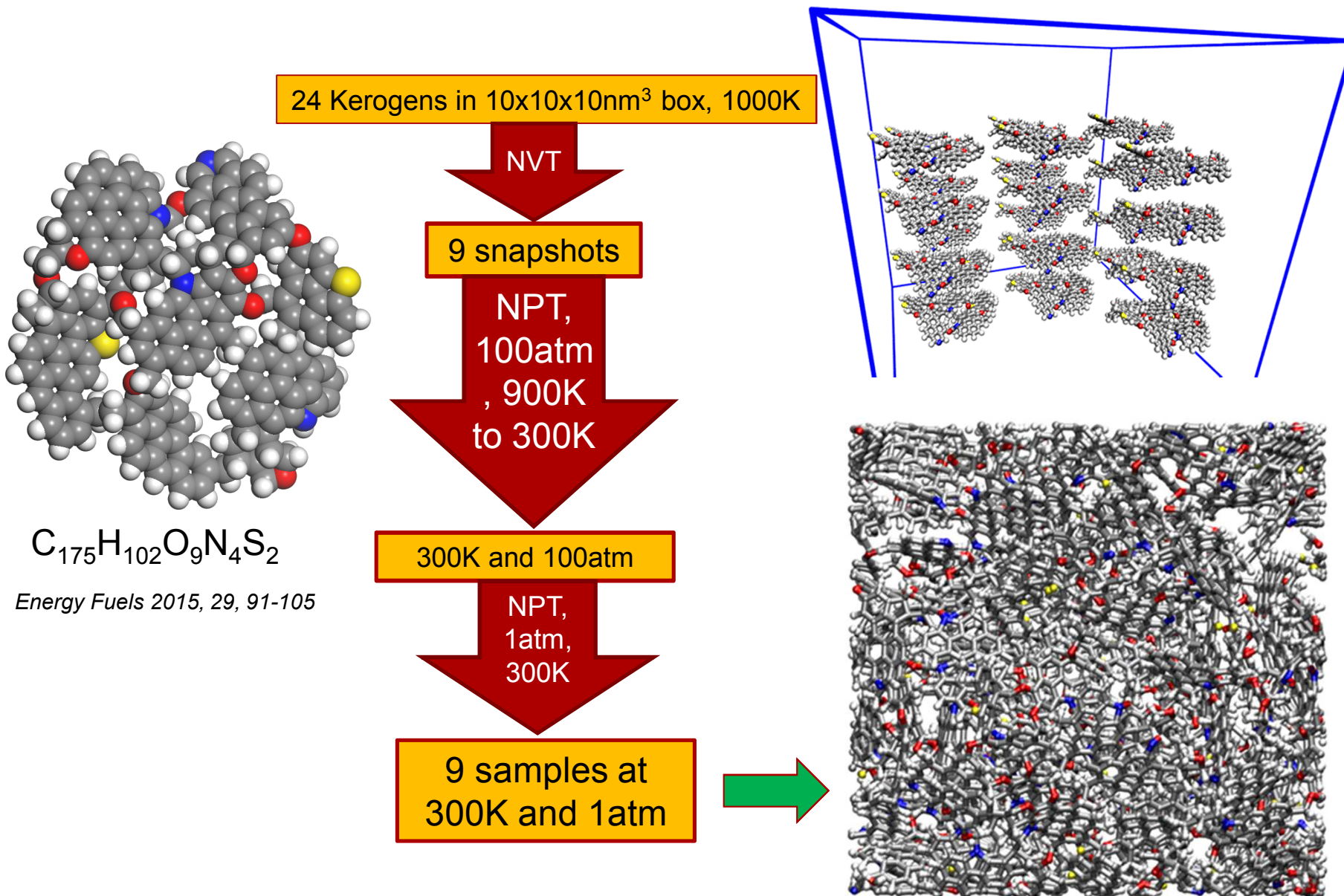
Kerogen IIC



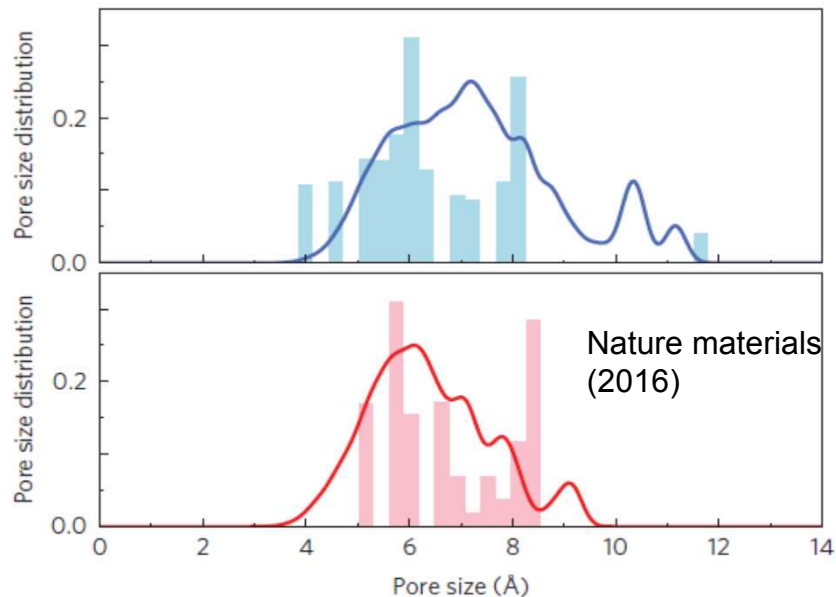
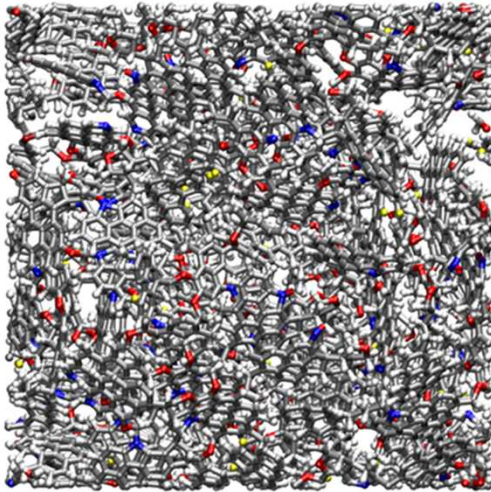
Kerogen IID

Ungerer et al., Energ Fuel 29, 91-105

Formation of condensed kerogen



Characterization



Density

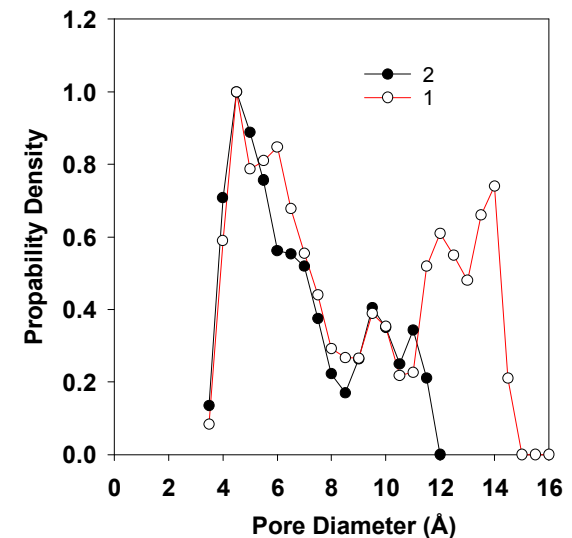
Sample 1: 1.172g/cm^3

Sample 2: 1.287g/cm^3

Average : $1.22 \pm 0.04\text{g/cm}^3$
Experiment: $1.28 \pm 0.3\text{g/cm}^3$

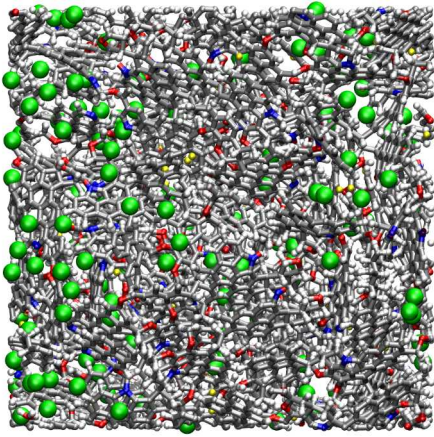
Stankiewicz A, *et al.* (2015) Kerogen density revisited – lessons from the Duvernay Shale. In: *Paper URTeC 2157904 at the Unconventional Resources Technology Conference, San Antonio, Texas, July 2015*

Pore size distribution



Method: Bhattacharya S & Gubbins KE (2006) *Langmuir* 22:7726-7731 5

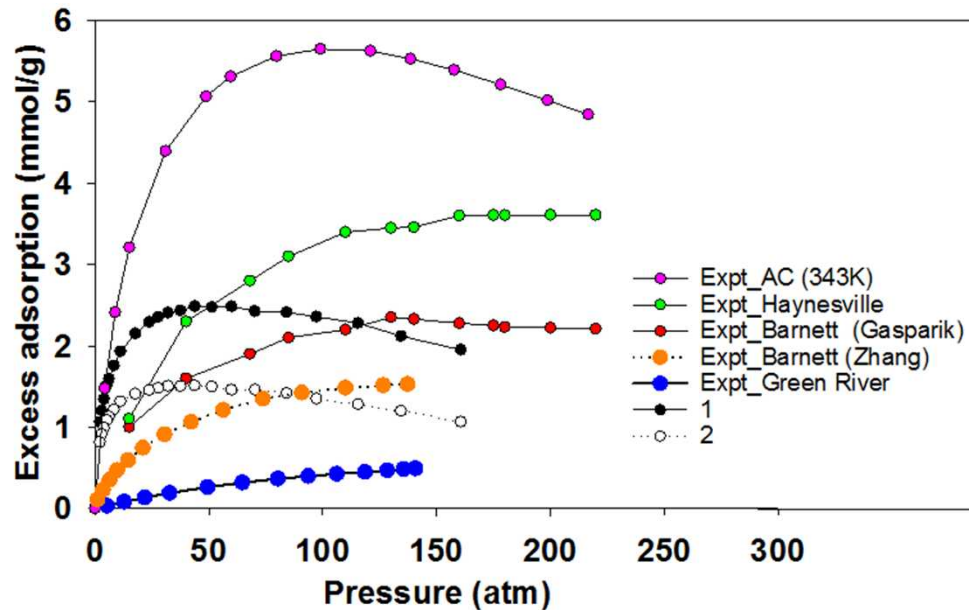
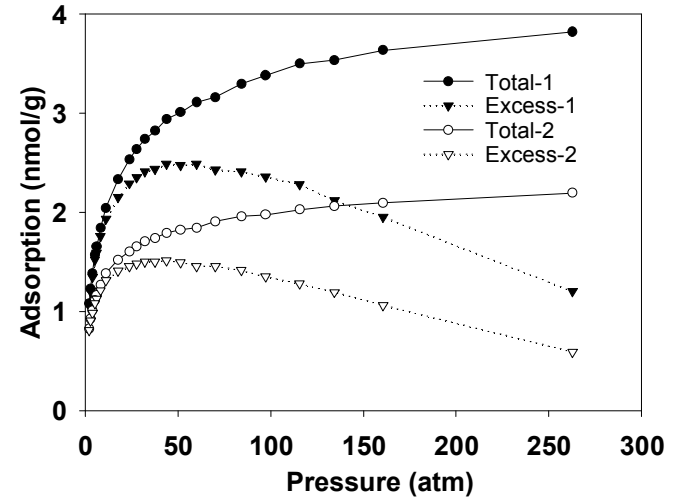
Methane adsorption



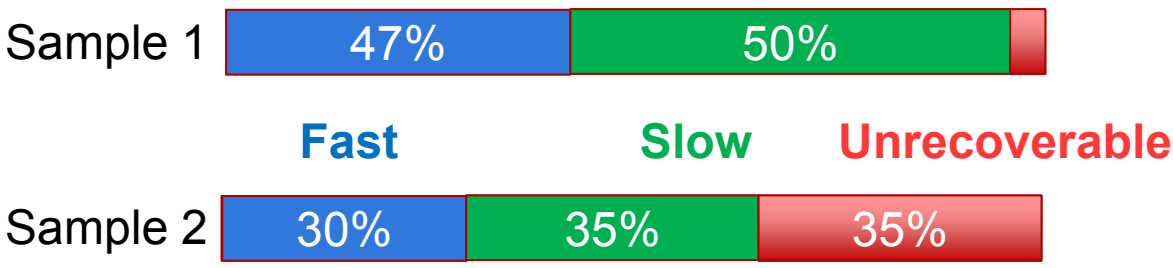
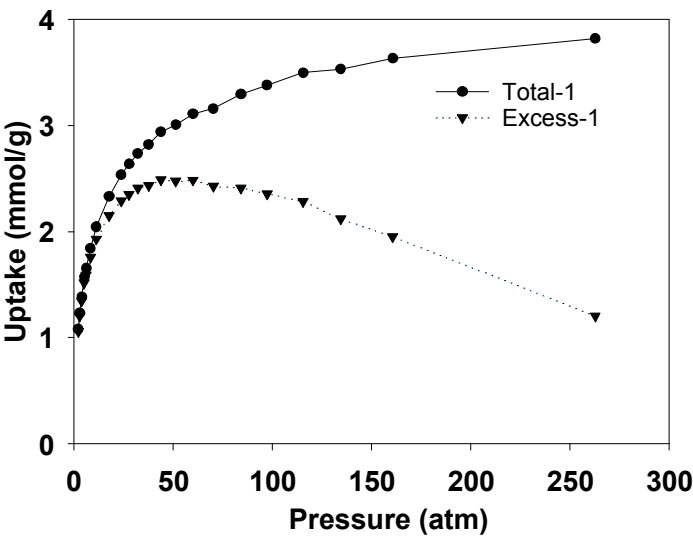
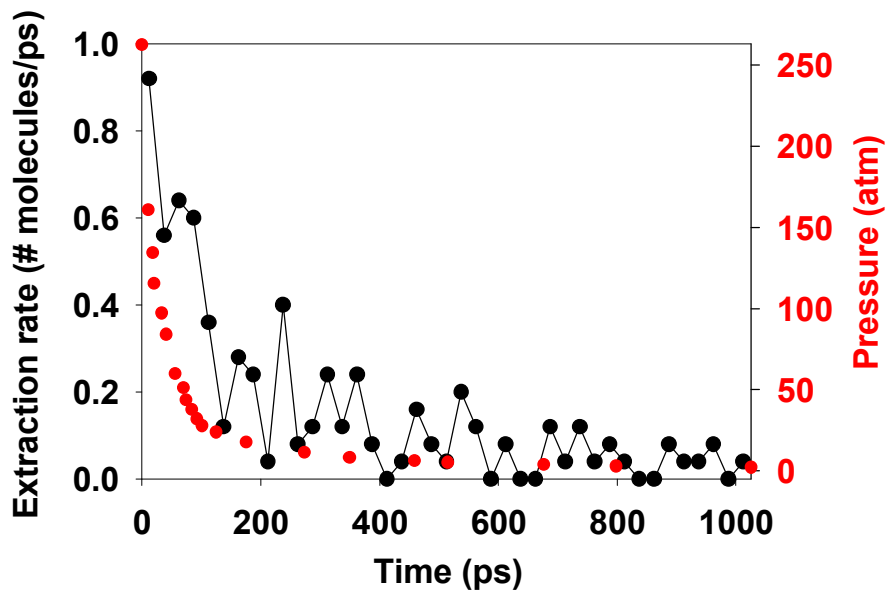
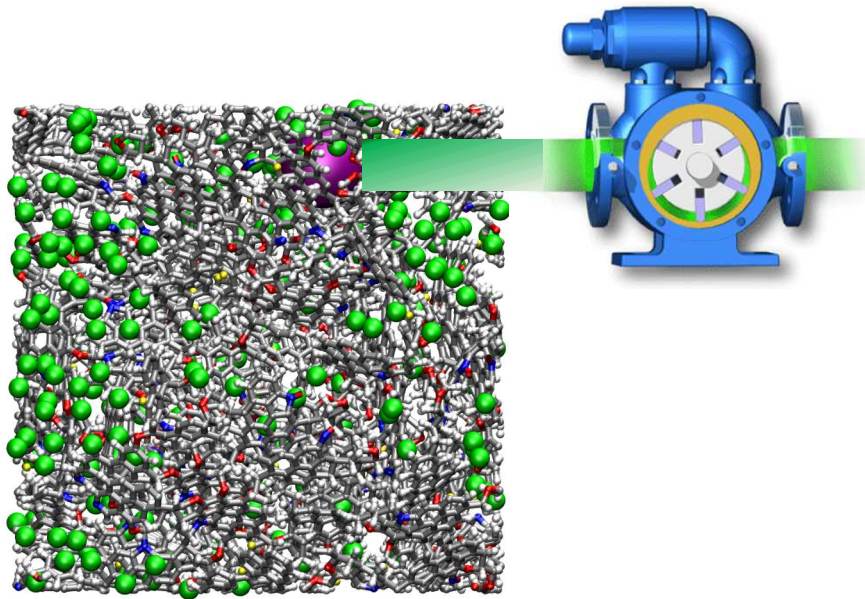
Total adsorption
Excess adsorption

$$n_{\text{excess}} = n_{\text{total}} - \rho_{P,T} V_{\text{free}},$$

Method: GCMC simulations

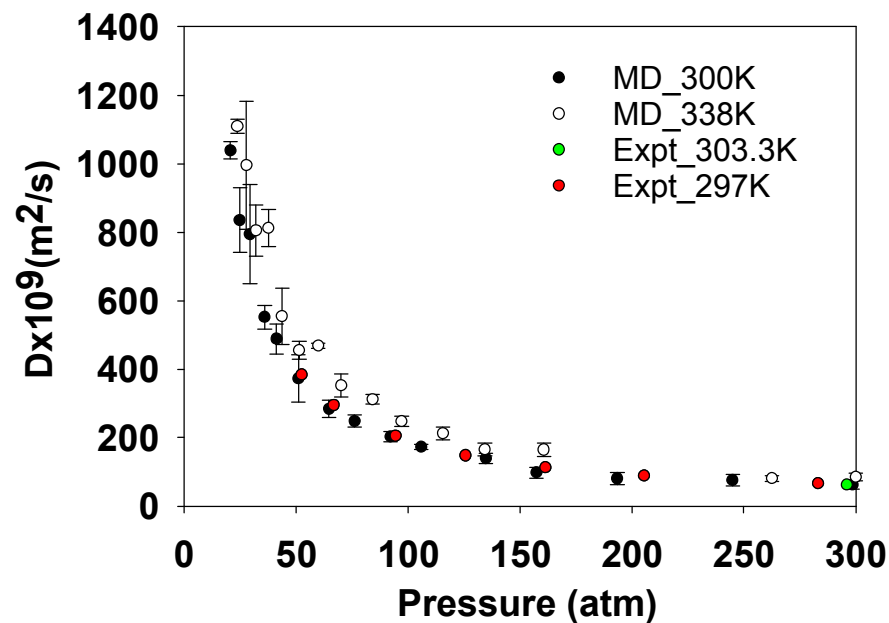
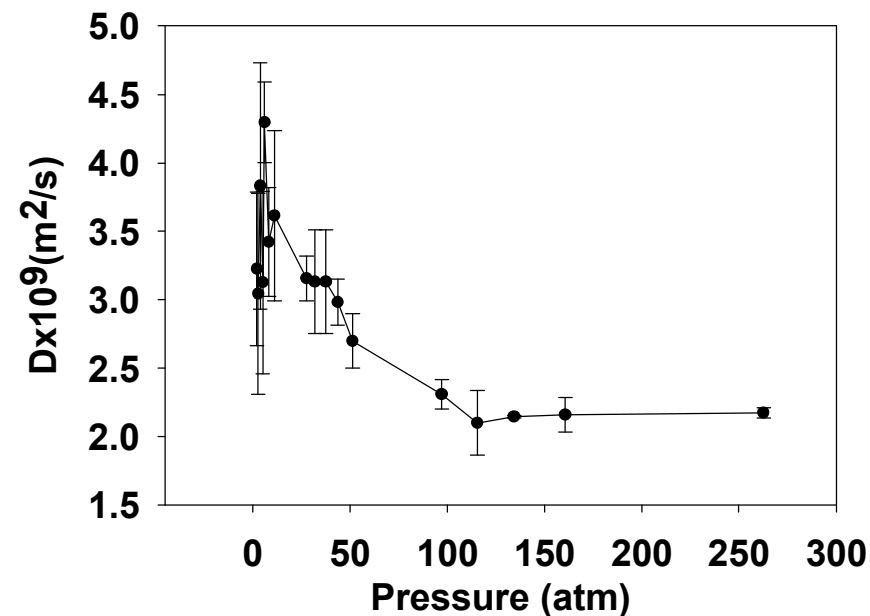
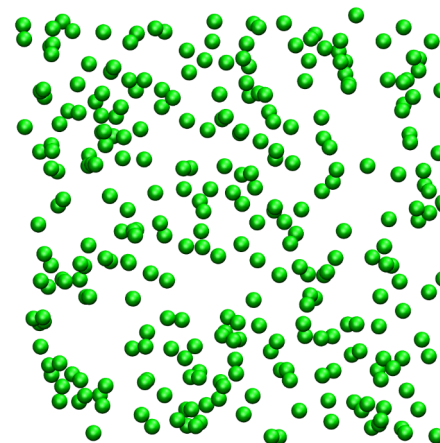
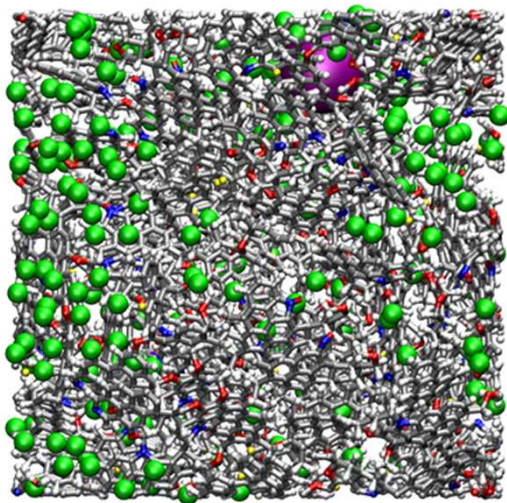


Methane extraction from kerogen



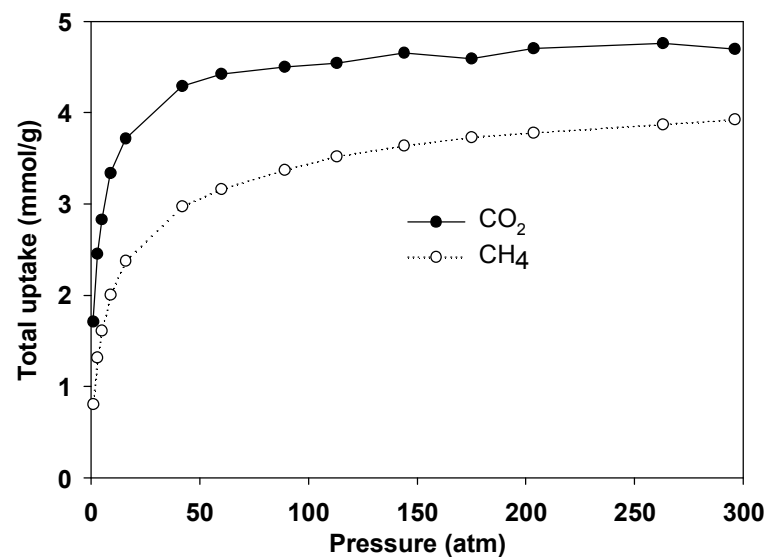
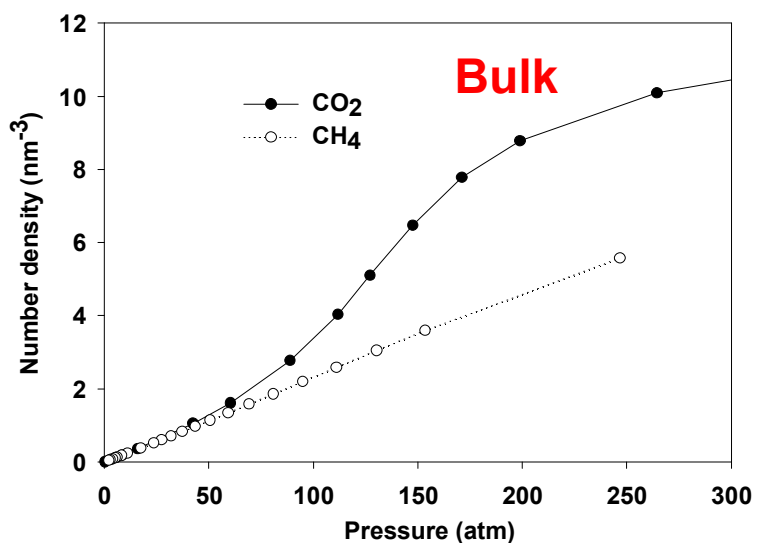
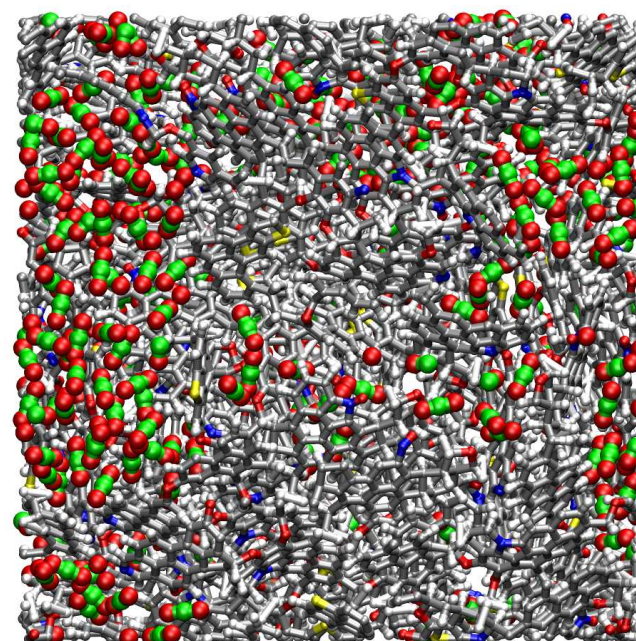
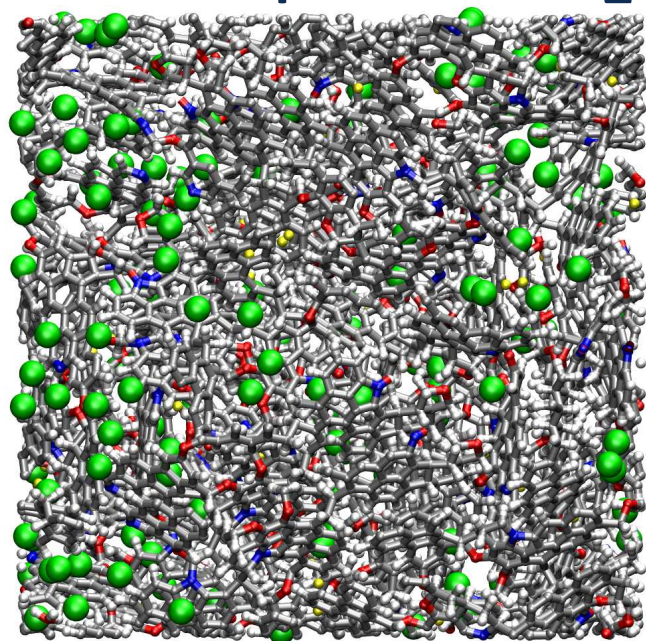
Scientific Reports, 6, 28053

Properties of methane in kerogen

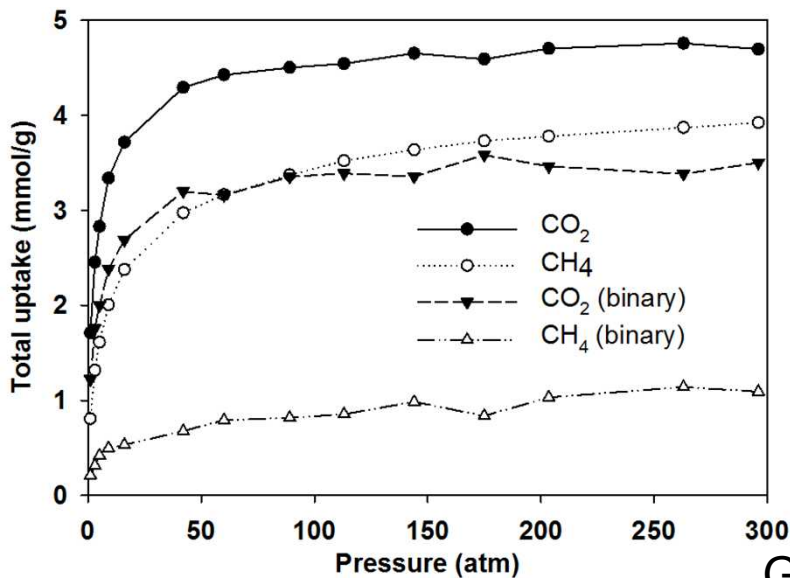
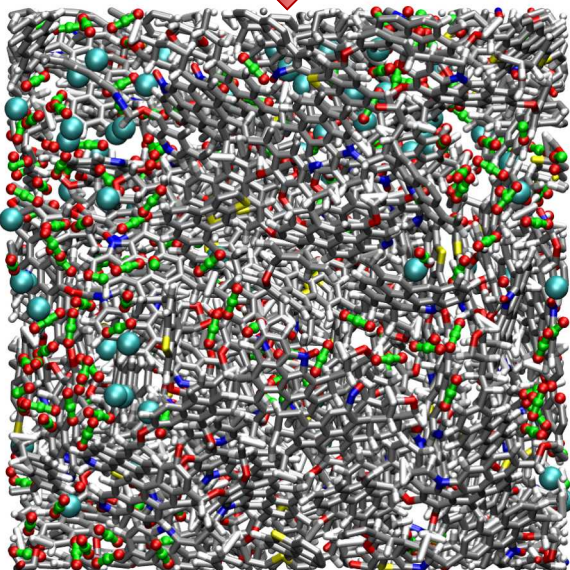
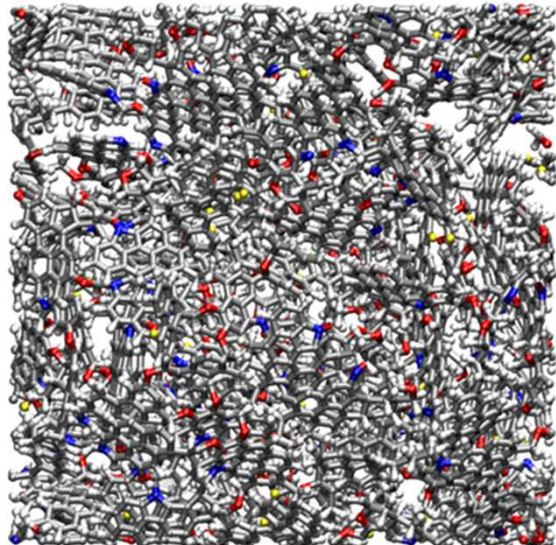
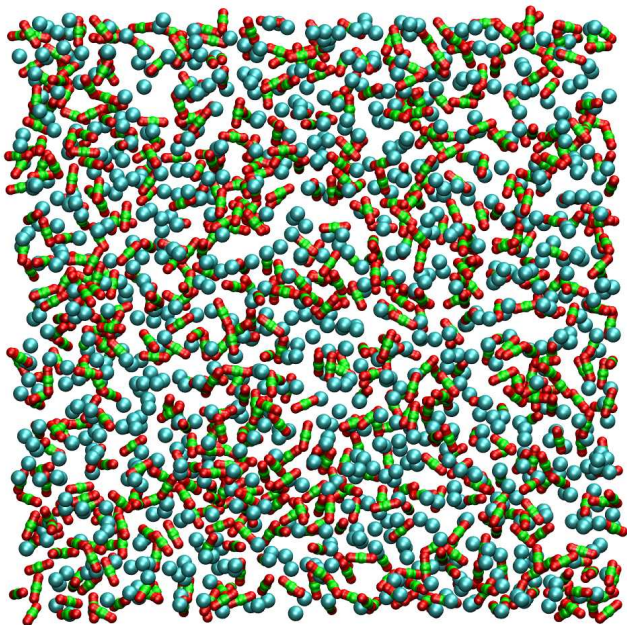


J Chem Eng Data **41**, 598-603 (1996)
Aiche J **16**, 725 (1970)

Pure CH₄ and CO₂ adsorption

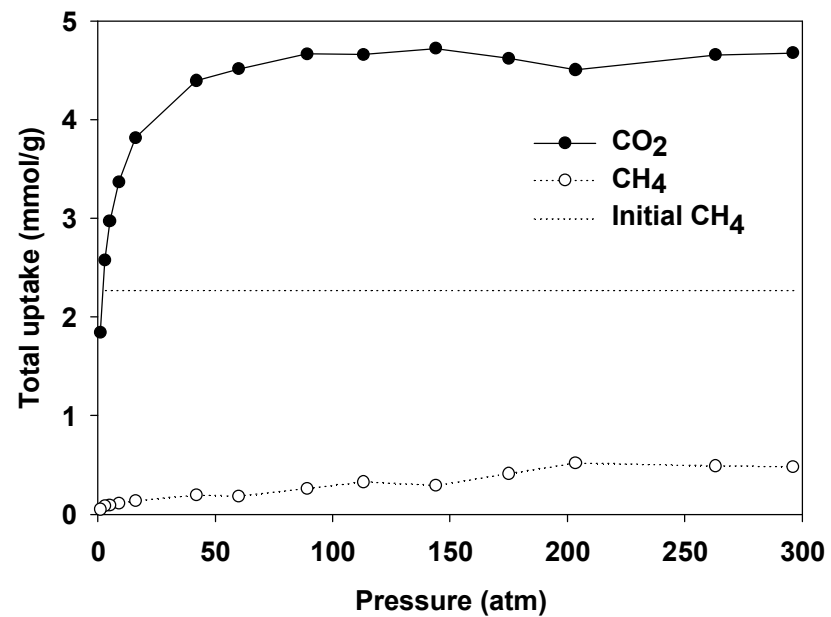
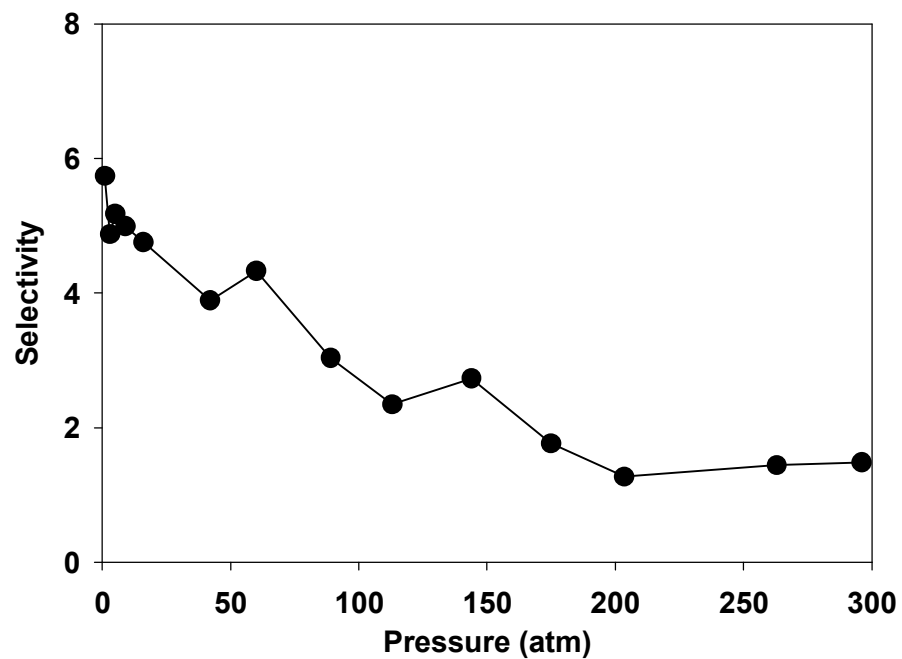
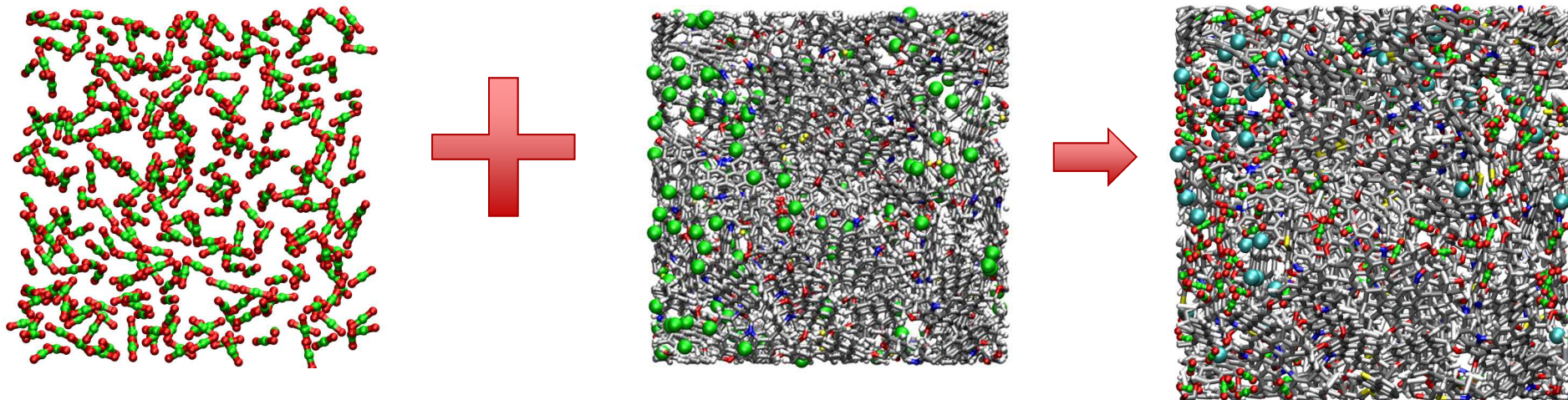


Binary mixture of CO₂ and CH₄

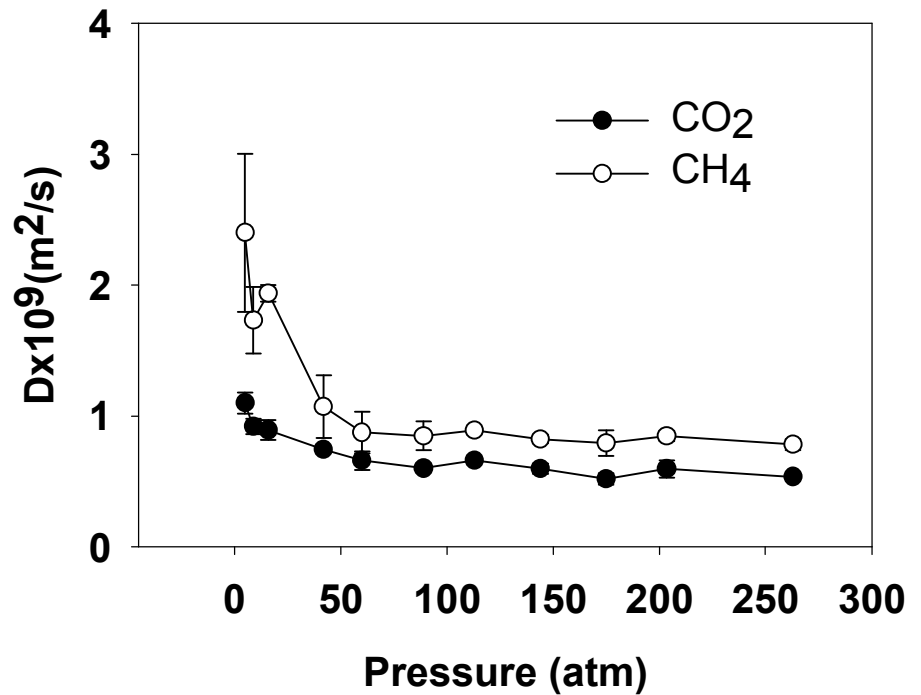
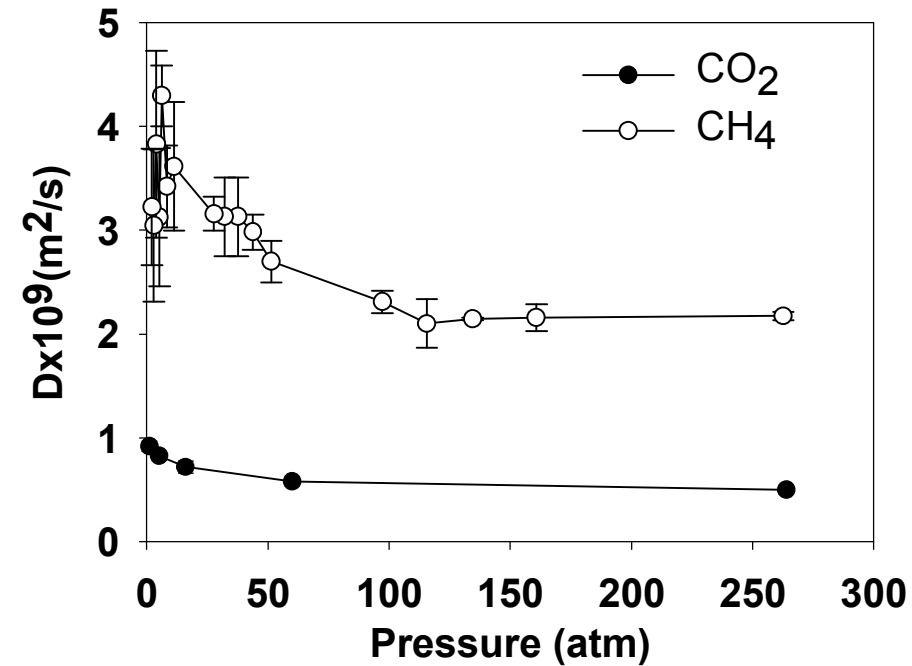


Gibbs-NPT MC

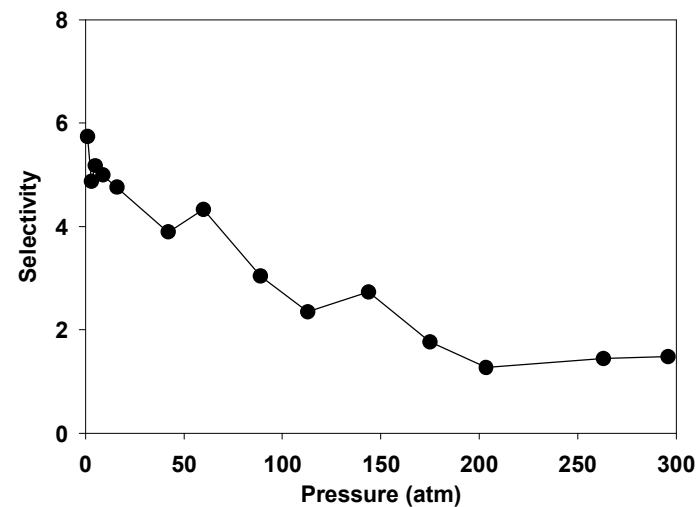
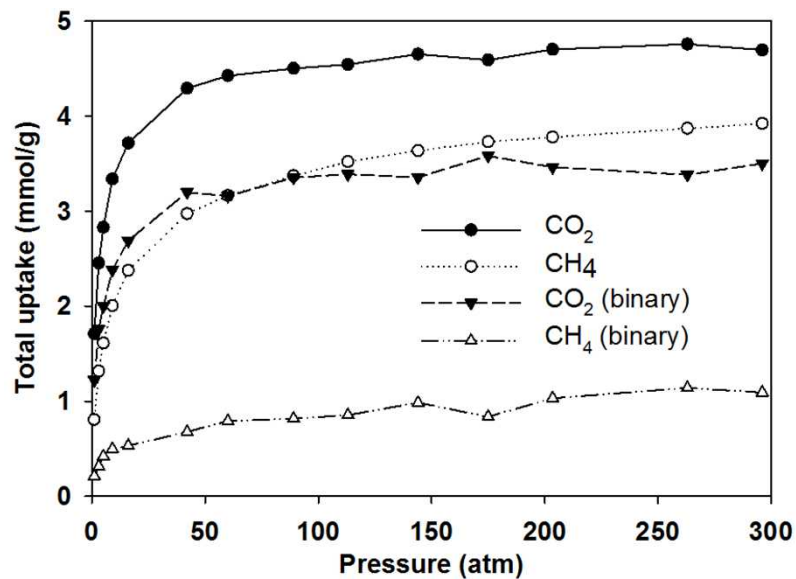
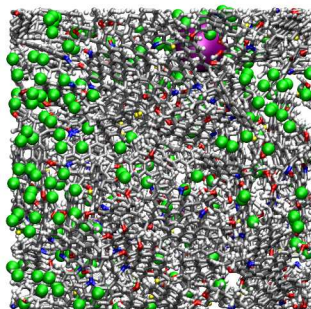
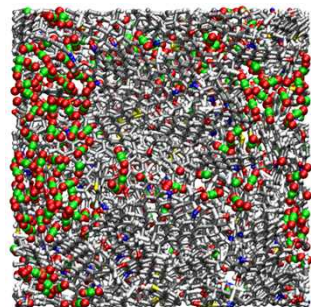
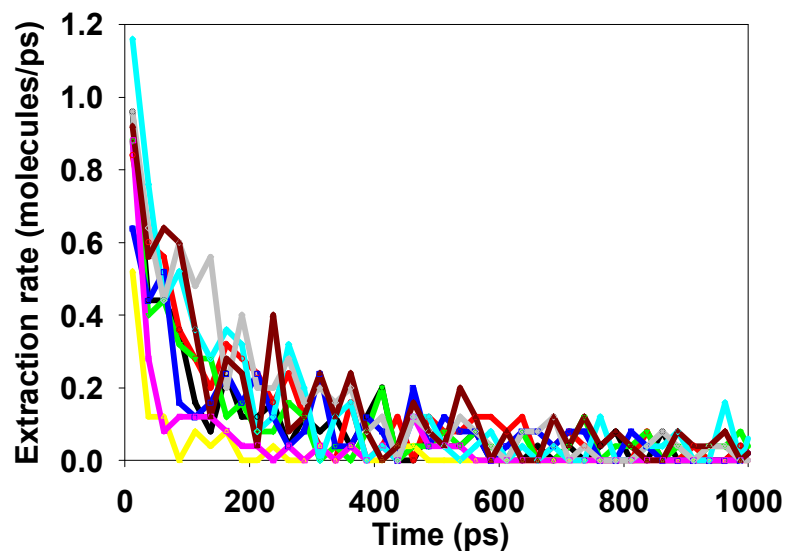
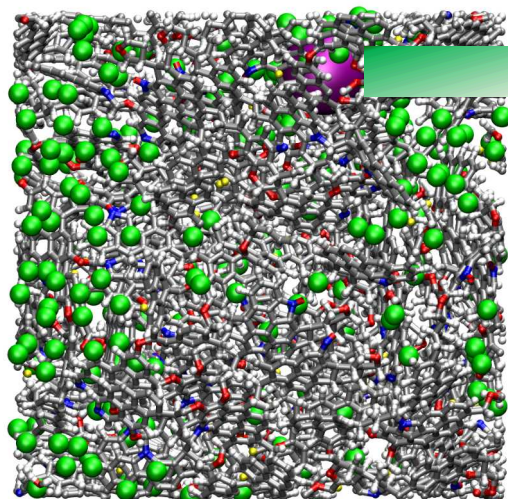
Enhanced gas recovery



Properties of CH₄ and CO₂ in kerogen



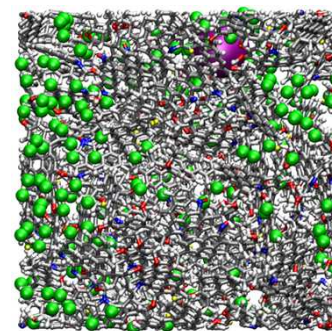
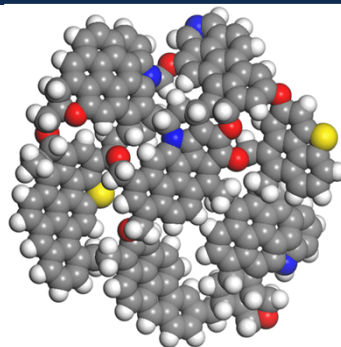
Conclusions



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Acknowledgement:

- Dr. Mark Rigali
- Dr. Susan Altman

Funding: LDRD: Kerogen + CH₄
NETL: Kerogen + CH₄ + CO₂



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