



SPE Workshop: Adaptive Approach in Integrated Reservoir Modelling and Simulation in the Age of Digitalisation

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PORE-NETWORK MODELLING AN ALTERNATIVE RESERVOIR SIMULATOR FOR CHARACTERIZING RESERVOIR BEHAVIOUR AND RESERVOIR PERFORMANCE

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RESERVOIR MANAGEMENT GROUP

The Miracle of Nature



Ant Nest

Human Bone

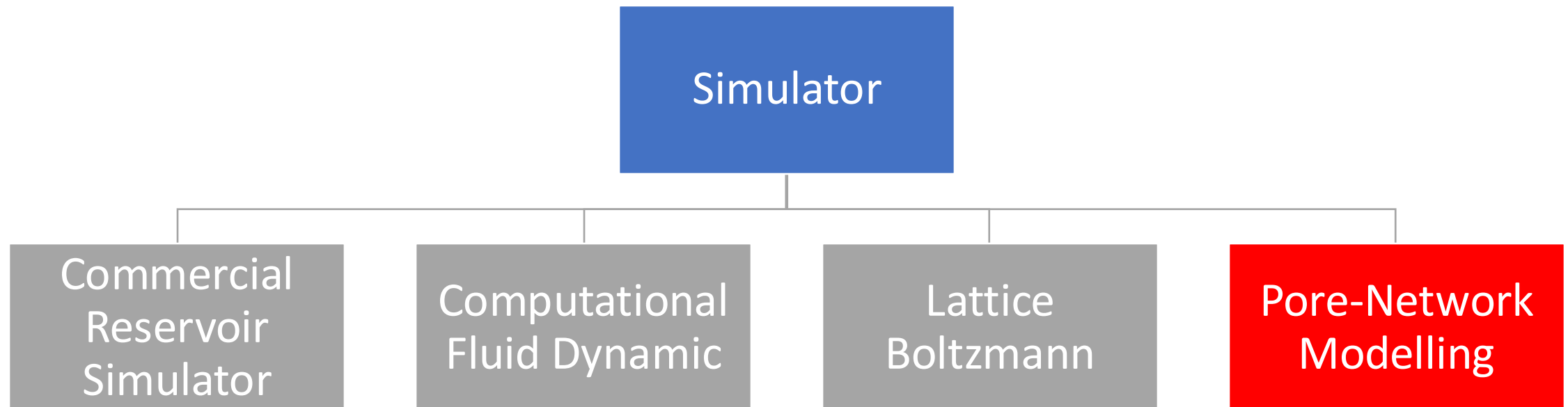


Sand and beach

Common: Inter-connected pathway is called pore-space or effective

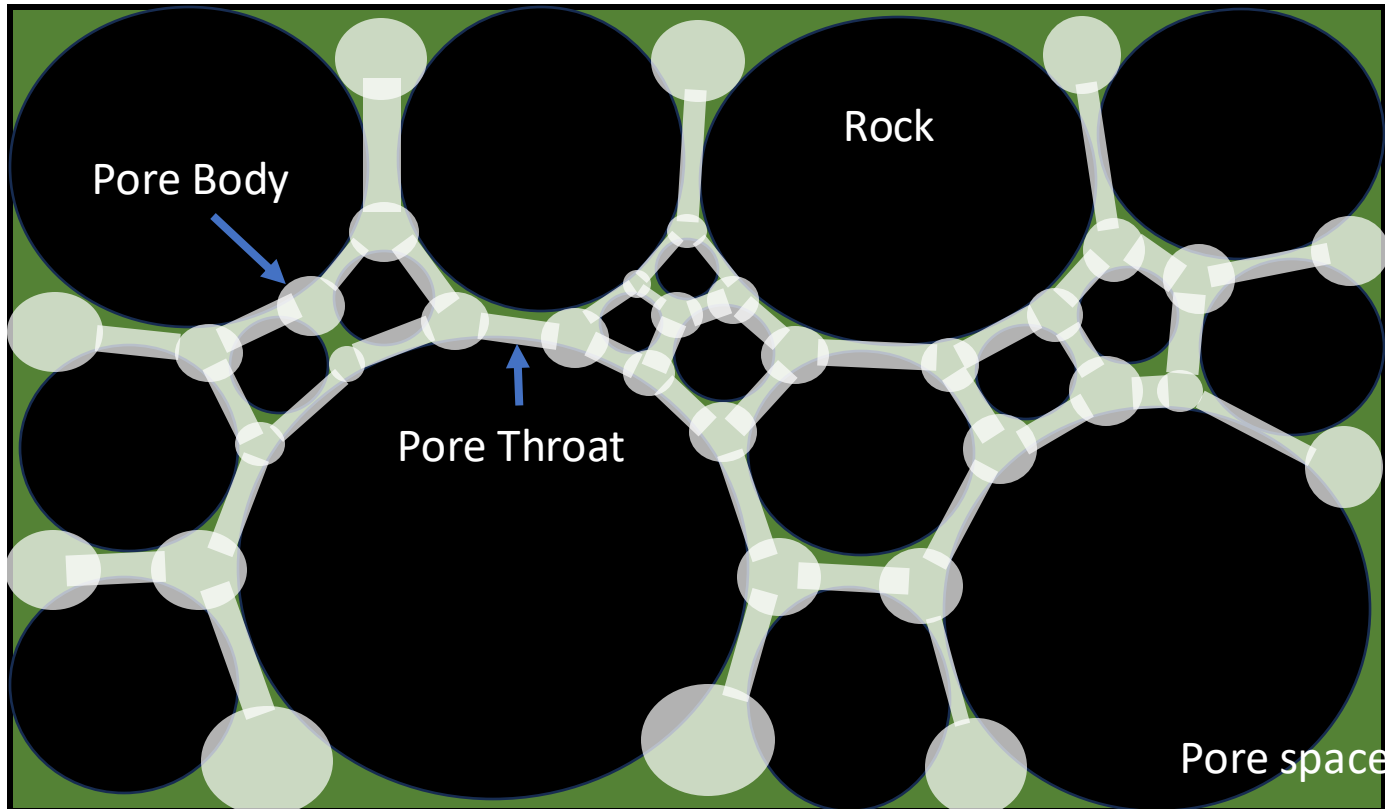
Simulation in View of Porous Medium

Converting the physical matter into simulation is done with the assistance of partial differential equation (∂)



Pore-Network Modelling (PNM)

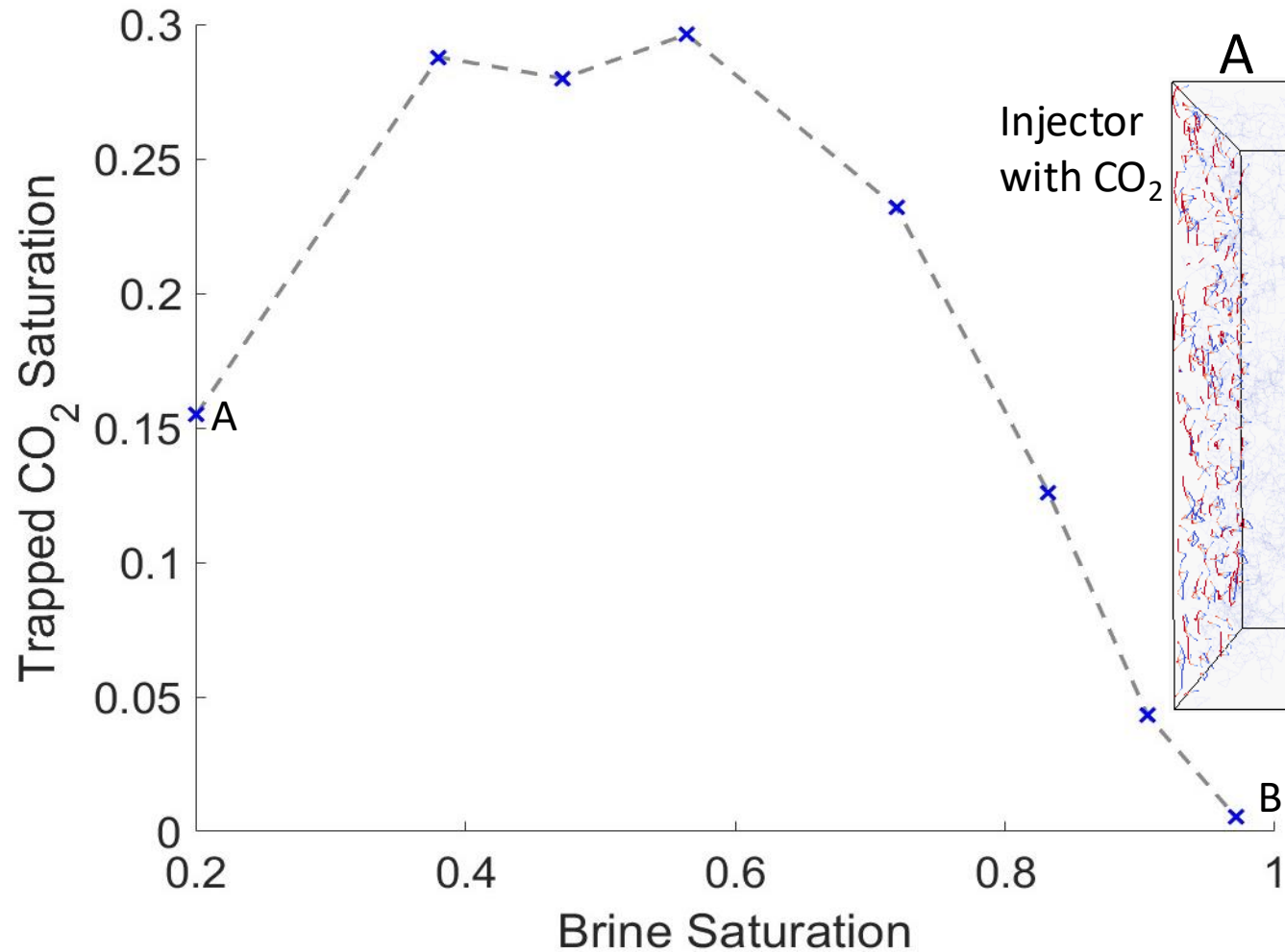
Convert the pore space to a known geometric. Pore Body – Sphere, Pore Throat - Cylinder



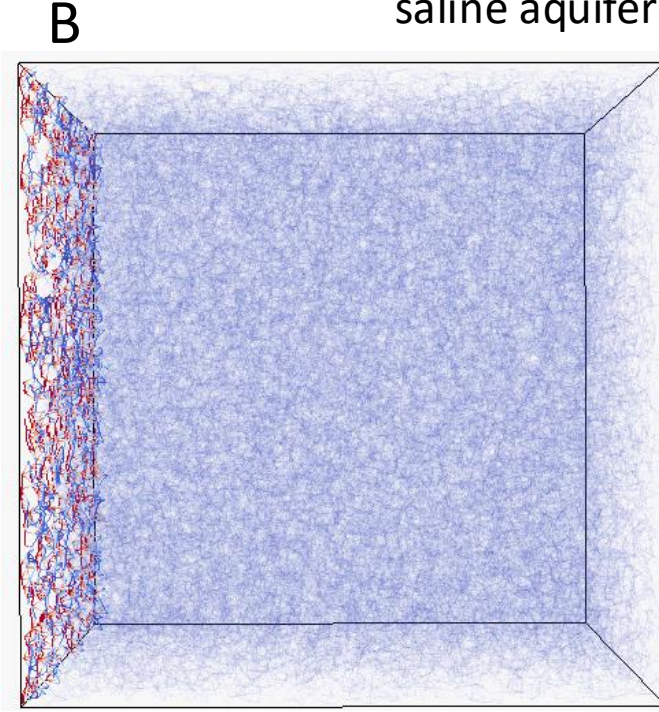
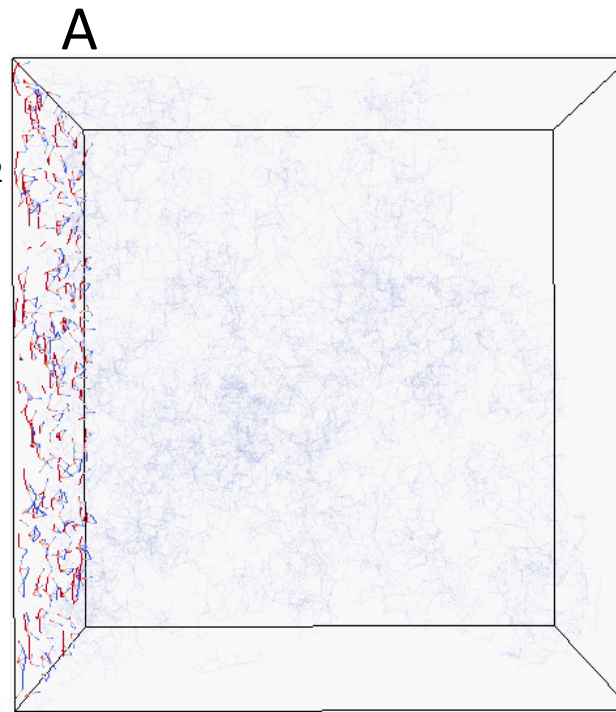
Dynamic simulation is done to the generated network with known structure of pore space. Example:

1. Carbon storage
2. Fine migration

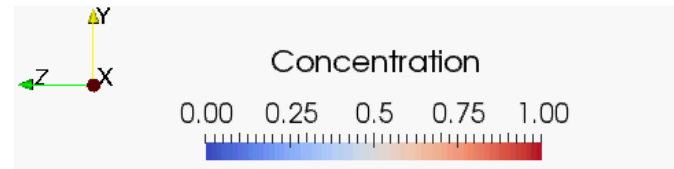
Result: PNM for Carbon Storage



Injector with CO₂



Inside the saline aquifer

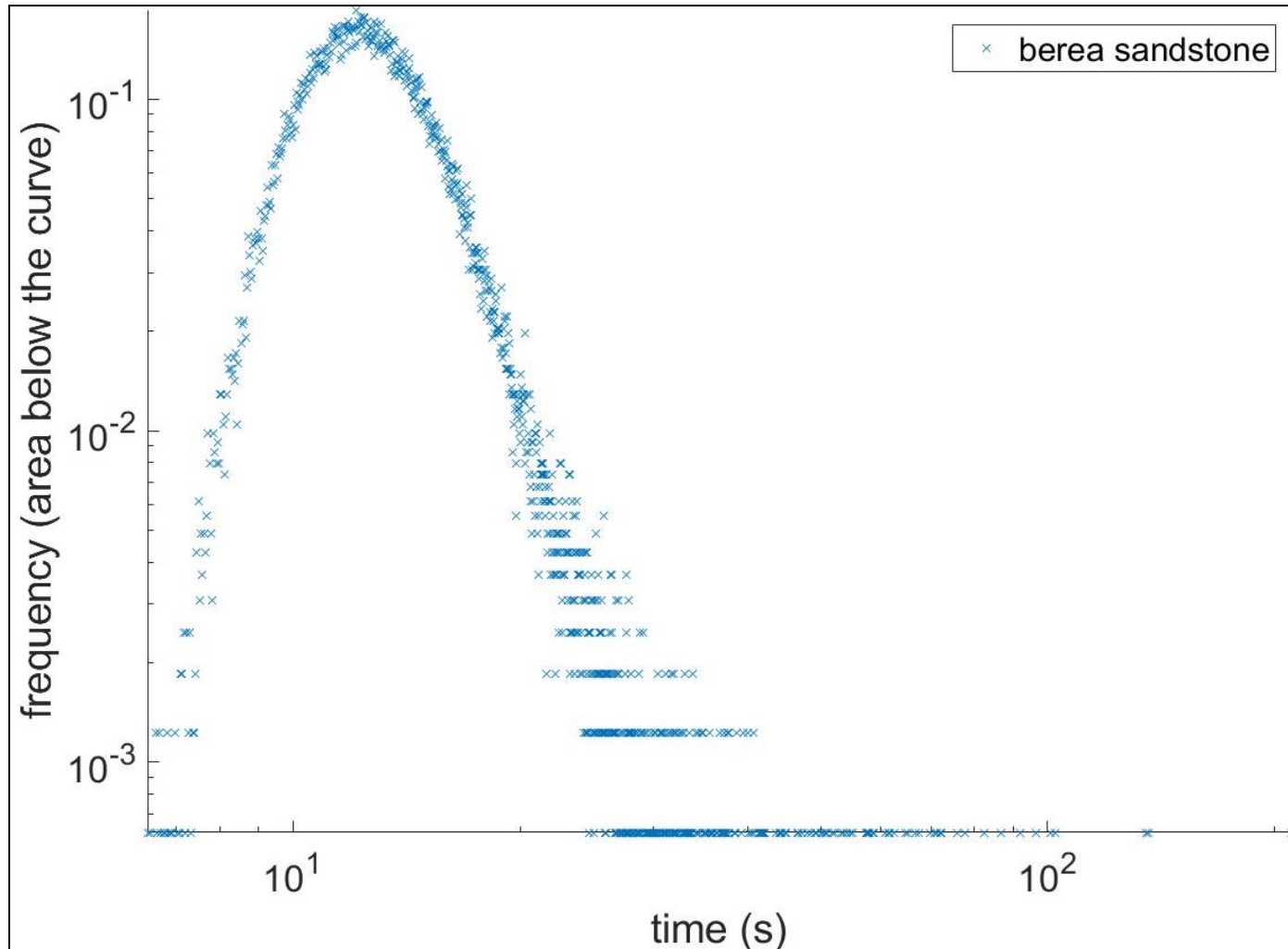


- brine
- CO₂
- Ink

[2] S. Hasan, V. Joekar-Niasar, N. K. Karadimitriou, and M. Sahimi, vol. 55, no. 2, pp. 1153-1166, 2019/02/01 2019.

[3] An, S., Hasan, S., Erfani, H., Babaei, M., & Niasar, V. (2020). *Water Resources Research*, 56(8),

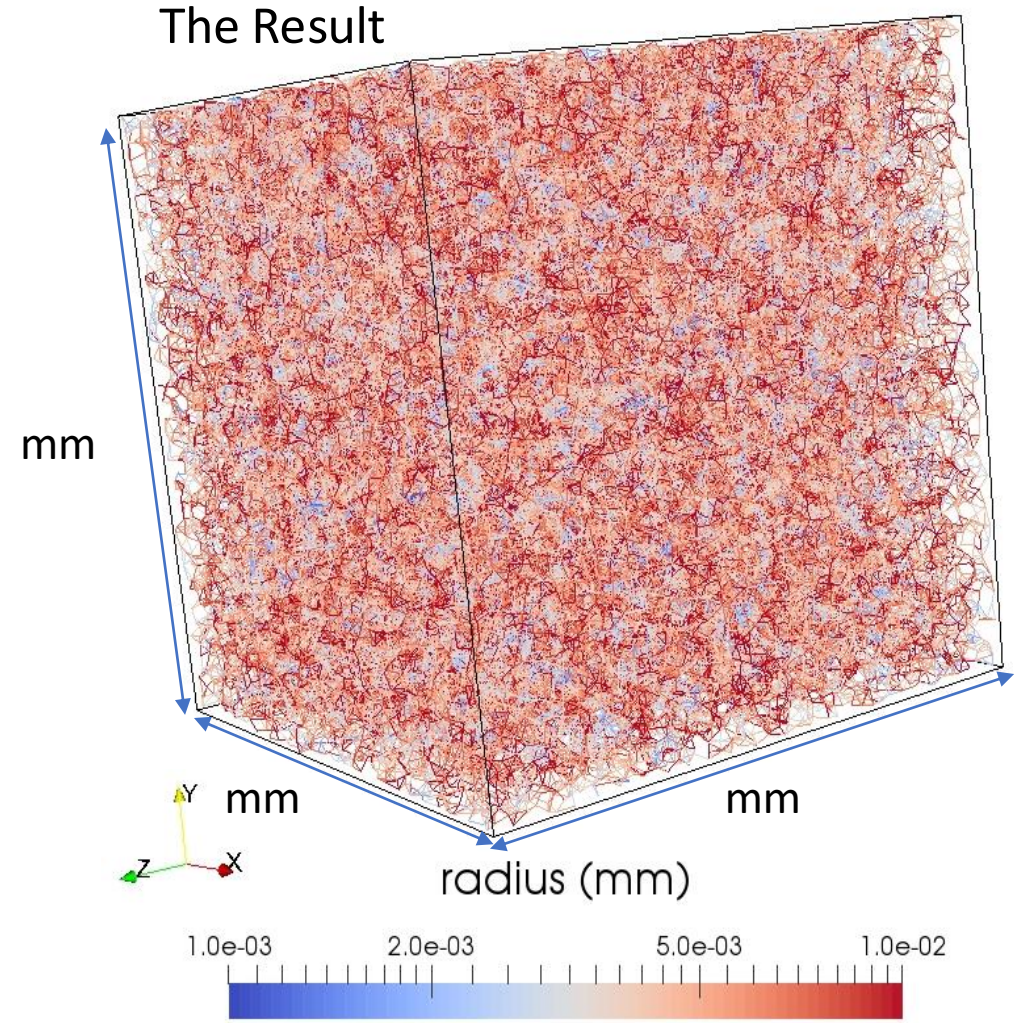
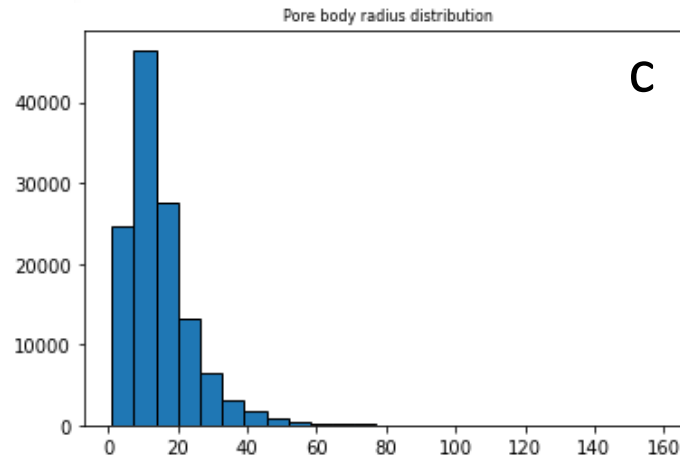
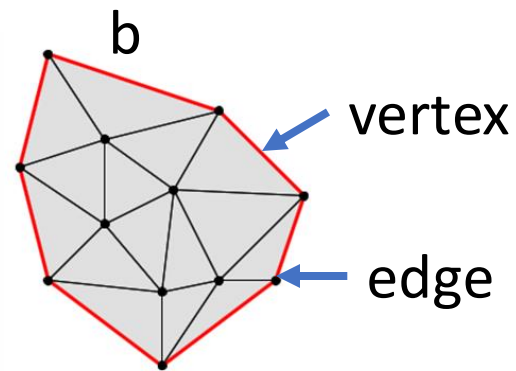
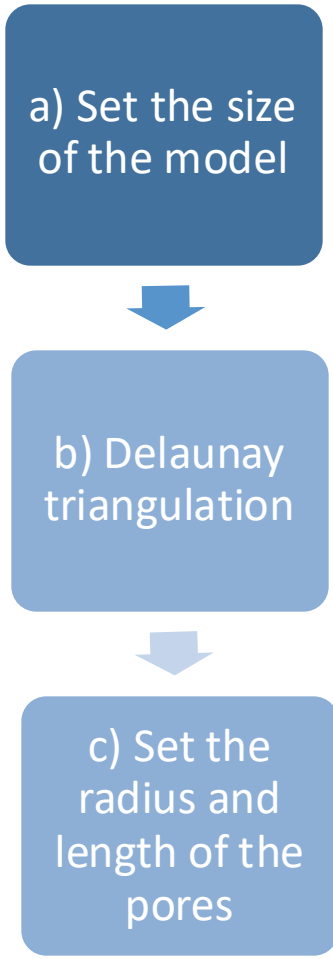
Result: PNM for Fine Migration



- Time the fines arrive at the well
- 50000 fines were introduced into the rock
- The drawdown pressure is 2500 Pa
- The size of the static model (Berea SST) is 40 mm by 40 mm by 40 mm
- Berea SST is homogeneous rock

Developing the PNM Static Model

Develop using Python



Simulating Flow of CO₂ and Fine

Develop using Fortran with parallel computing

Carbon Storage

Fine migration

Assigned condition to the generated static model

Assigned condition to the generated static model

Simulated velocity field

Simulated velocity field

$\sum V_{ij} = 0$
Above equation indicates the amount of CO₂ injected at given saturation

$\sum V_{ij} = 0$
To obtain the water velocity in each pore

Simulated transport

Simulated fine migration

$D(\nabla \cdot \nabla c) - v \nabla c = \frac{\partial C}{\partial t}$
Above equation identifies the trapped CO₂

$T(x) = T(x') + \frac{L}{v}$
Probability generator to indicate which area the fine migrated

Way Forwards

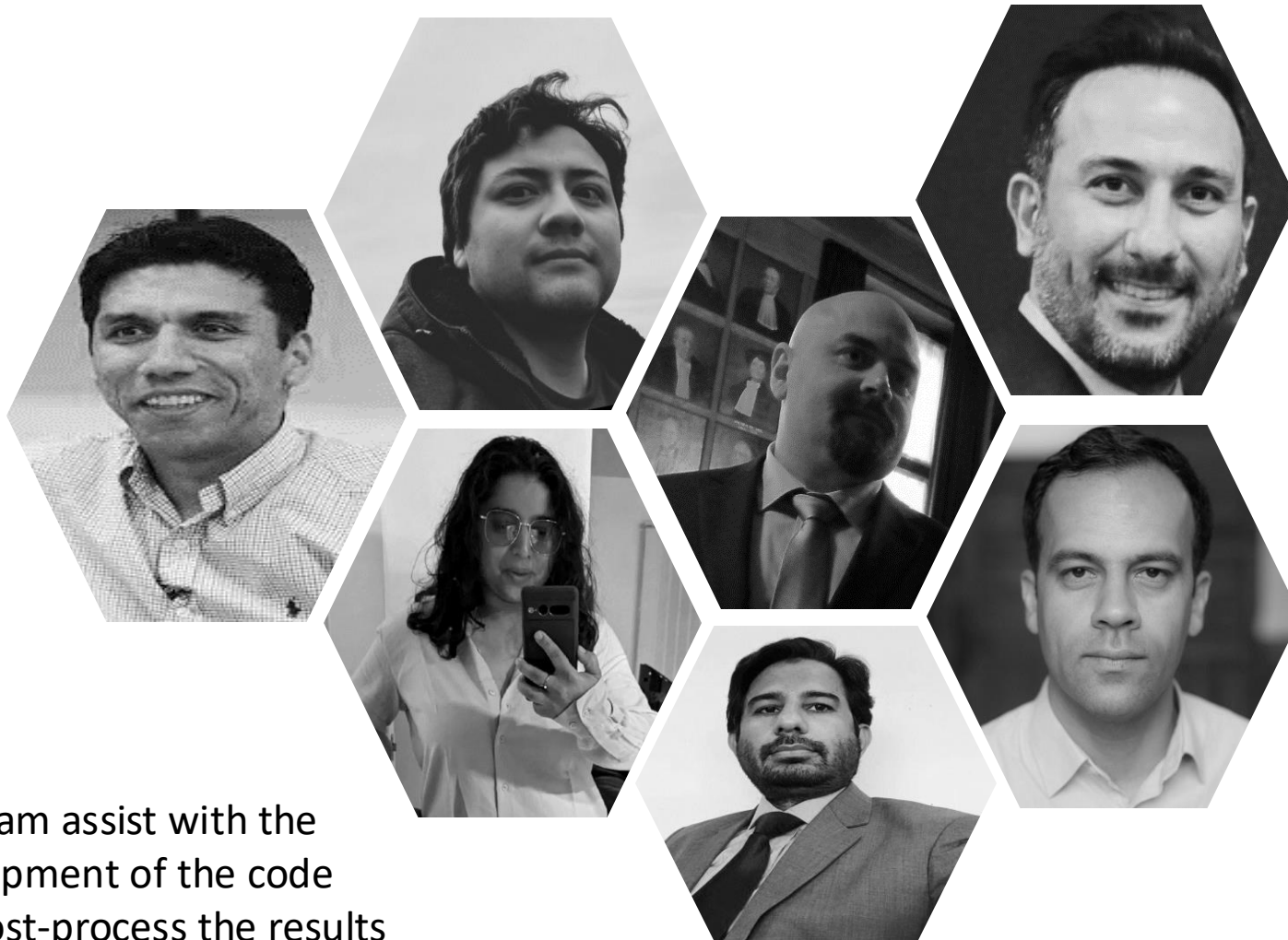
Carbon Storage

- Investigate the synergistic effect of two or more trapping mechanism
- Analysing the capability of brine alternate CO₂ injection strategy to enhance saturation of trapped CO₂

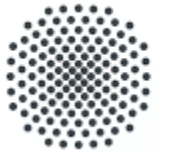
Fine migration

- Relating the fine migration simulator to critical drawdown pressure plot
- Investigating the migration time for different drawdown pressure

Deepest Gratitude to the Team



The University of Manchester



University of
Stuttgart



INEOS



The team assist with the development of the code and post-process the results



Thank you for your attention
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Session 1: Static Modelling and Reservoir Characterization

