Qatar Carbonates and Carbon Storage Research Centre

CO_2 storage session
UN-ESCWA / Masdar Meeting
6-7th November 2013

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QCCSRC Programme Manager

Imperial College London

Qatar Petroleum

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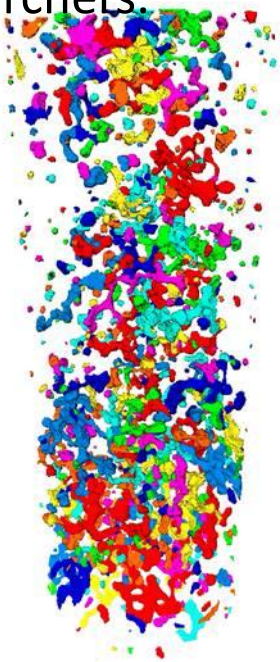
Qatar Carbonates and Carbon Storage Research Centre

Programme Overview

Multidisciplinary (Depts. Chemical Engineering & Earth Sciences and Engineering), 4 large carbon storage research projects, industry funded (Qatar Petroleum, Shell, Qatar Science and Technology Park), major science and technology transfer to Qatar, 10 years, $70M **signed in 2008**, involves >70 researchers.

Reservoir condition experiments (some with in-situ CT monitoring) allow fluid-fluid and fluid-rock interactions to be measured and models validated



First 3D micro CT images of residual/capillary trapped super-critical CO_2 in carbonate rock

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Programme Overview

- Builds on earlier Clean Fossil Fuels Shell-Imperial Grand Challenge
- Expands fundamental research thereby reducing uncertainty, feedback from reservoir samples / data / observations from sequestration studies
- Providing improved predictive tools for carbon sequestration
- Local capacity building
  - transferring knowledge and technology (people and equipment)
- 4 leading-edge laboratories with £6M CAPEX
- Integrating world-leading petroleum / chemical engineers with simulator group

QCCSRC Lab Opening Sep 2012, Imperial College London

UNFCCC COP 18, Nov 2012, Doha, Qatar

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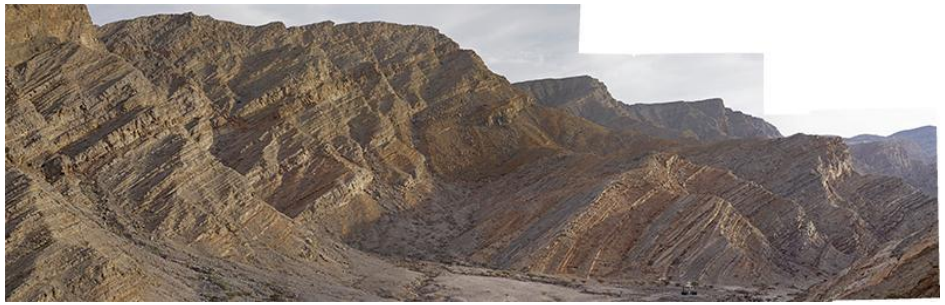
Qatar Stable Isotope Laboratory

Developing a new palaeothermometer technique “clumped isotope” for reservoir application. This supports outcrop based reservoir and seal sedimentology fieldwork and geochemistry lab work focusing on relevant epochs and fracture related dolomitisation to provide rules for geological subsurface model building.

Mass Spectrometer with specific C atom detection cups and gas preparation lines

Thin sections of outcrop samples with Cathodluminesence microscopy to observe different optical properties

Extensive, synchronous extensional failure associated with fluid induced failure in an extensional stress regime.



Mountain outcrops act as reservoir analogues for the Middle East to understand geobody dimensions and fracture patterns

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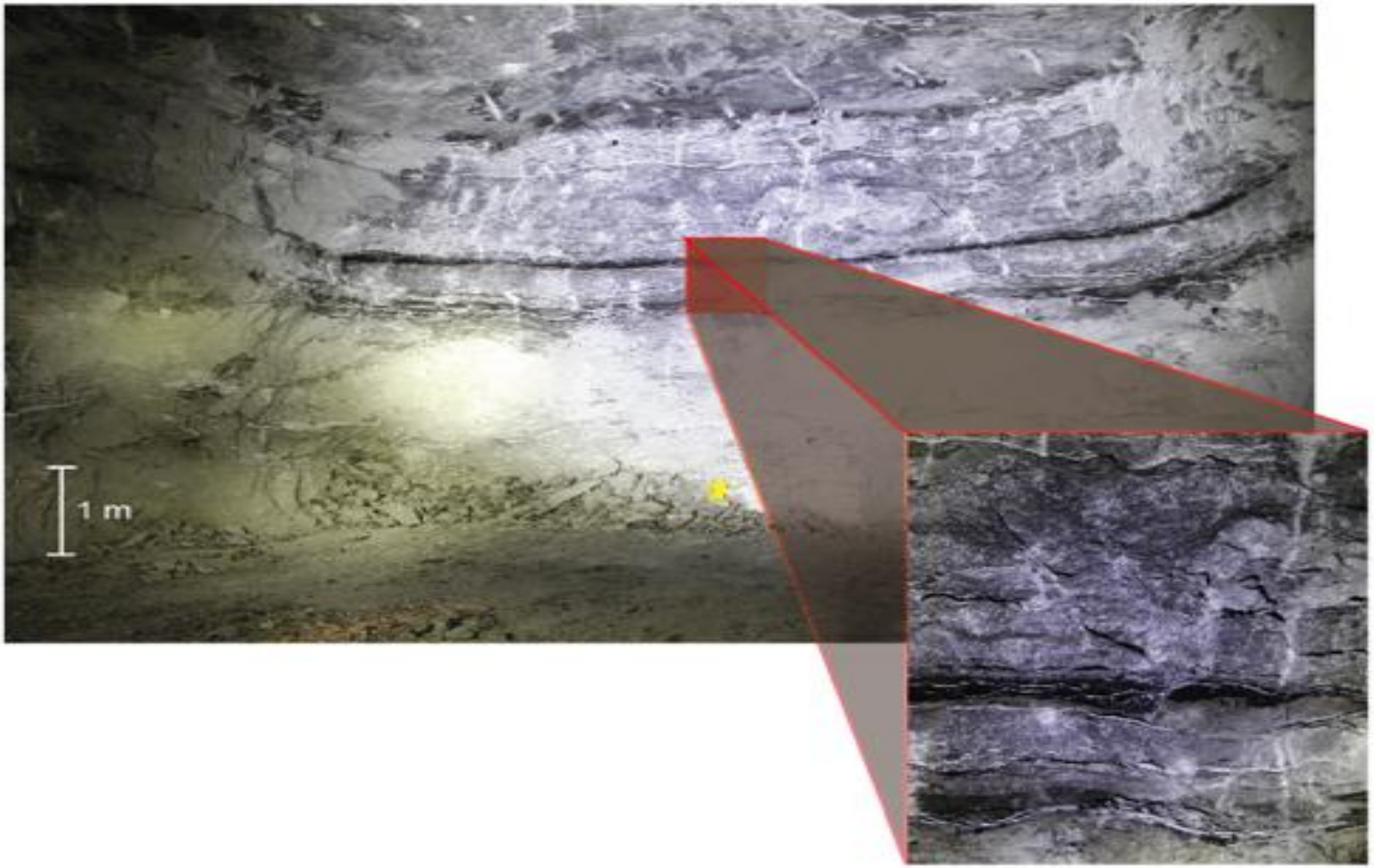
Seal Integrity



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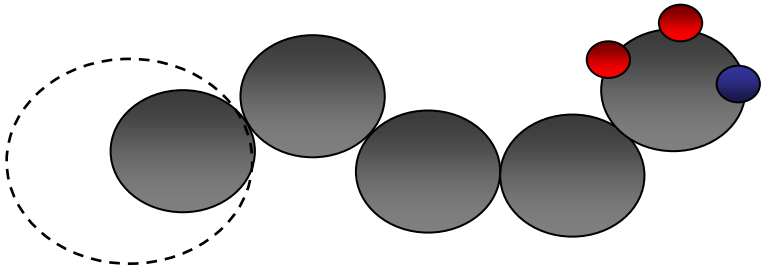
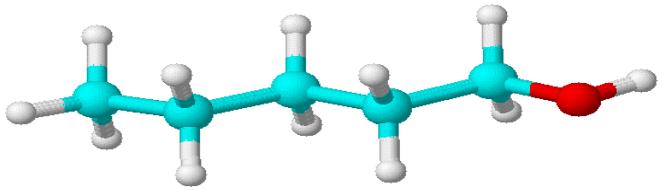
Qatar Thermophysical Properties Laboratory

Providing a wide array of experimental data (e.g., phase behaviour, viscosity, density, pH, interfacial tension, contact angles, reaction rates / kinetics) at reservoir conditions of representative fluid mixtures for validating EoS (SAFT) and transport models (VW method).

HTHP Interfacial Tension Rig



HTHP Analytical Phase Behaviour Rig close up of vessel viewing port



SAFT-VR Mie

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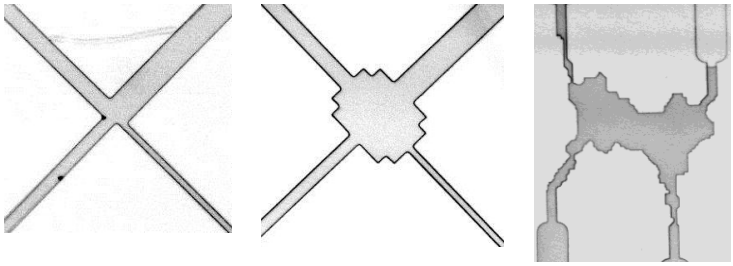
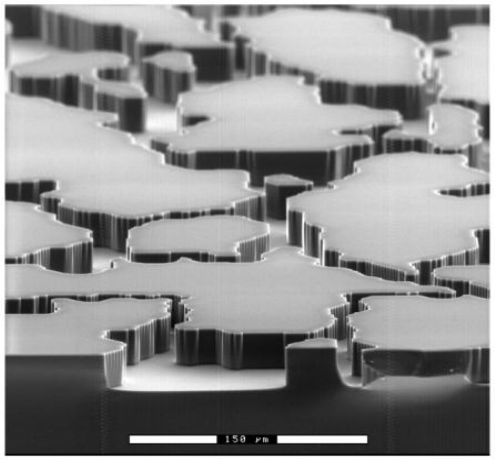
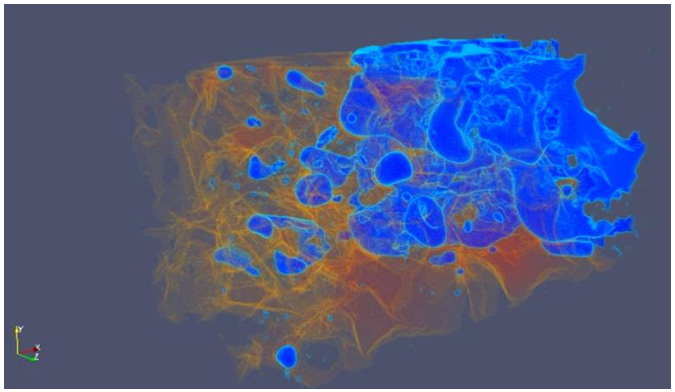
Qatar Complex Fluids Laboratory

Providing simplified micro-models to validate assumptions during imbibition and drainage to improve lattice Boltzmann and pore network model petrophysical property predictions.

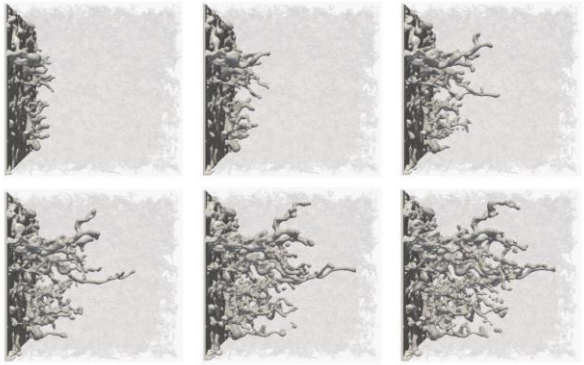




HTHP micro-model validation of pore filling events.



Lattice Boltzmann CPU simulation of imbibition



Lattice Boltzmann multi GPU simulation of imbibition

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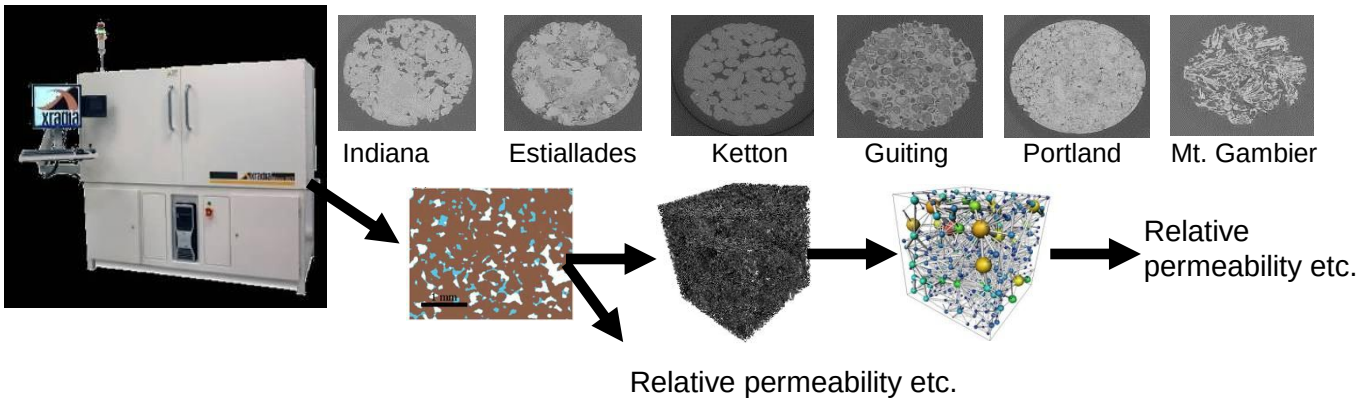
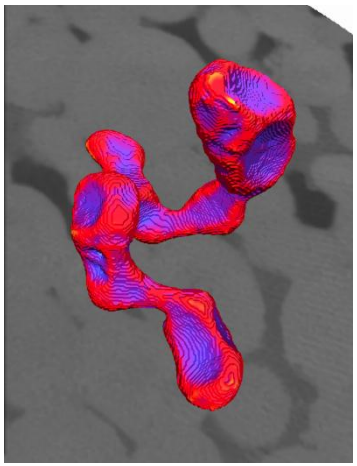
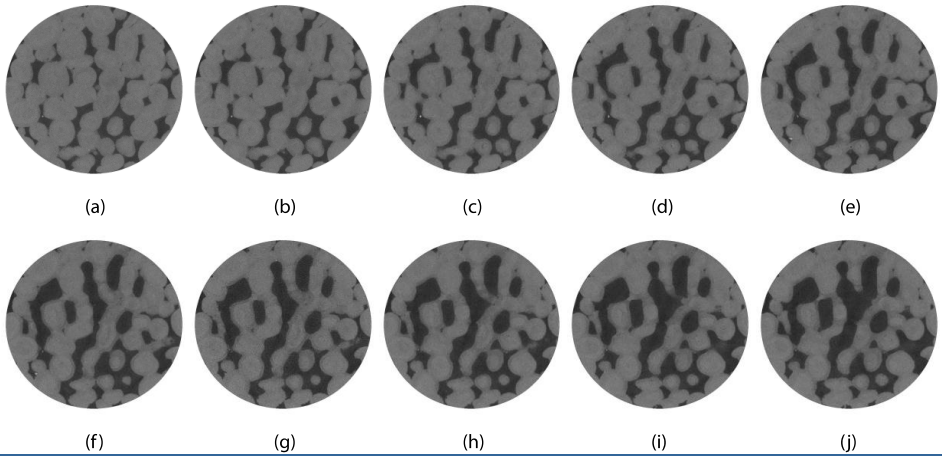
Qatar CCS Multiscale Imaging Laboratory

Pioneering reservoir conditions petrophysical property measurements at pore and core scales and with multiphase and reactive flow.







Dynamic observations of reactive (dissolution) flow

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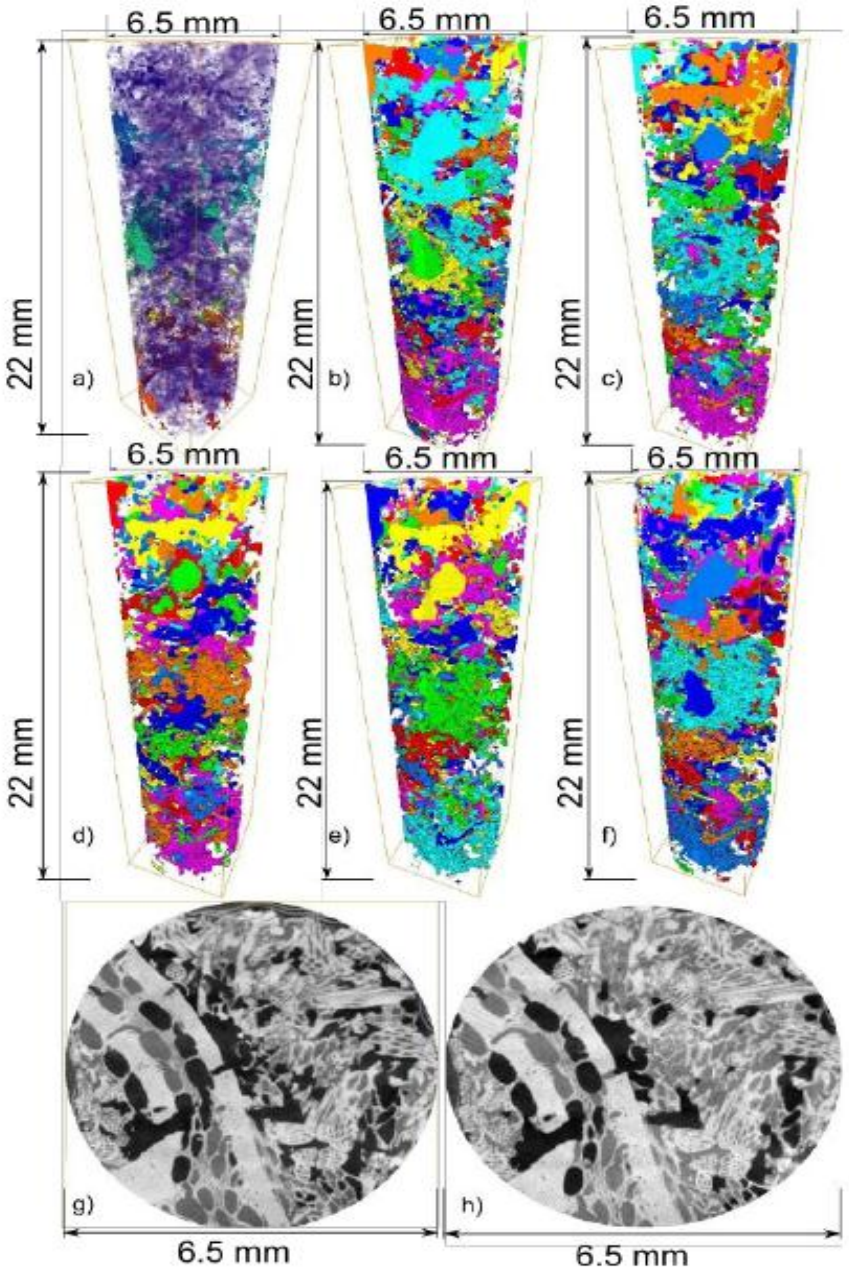
Carbonate core after drainage and b –f as imbibition. Different colours are different CO_2 clusters

<u>Overall CO_2 capillary (residual) trapping sandstones > carbonates, both significant ~ 70% of efficiency</u> (the fraction of the initial $scCO_2$ which is trapped in place after waterflood; Sr/Si)



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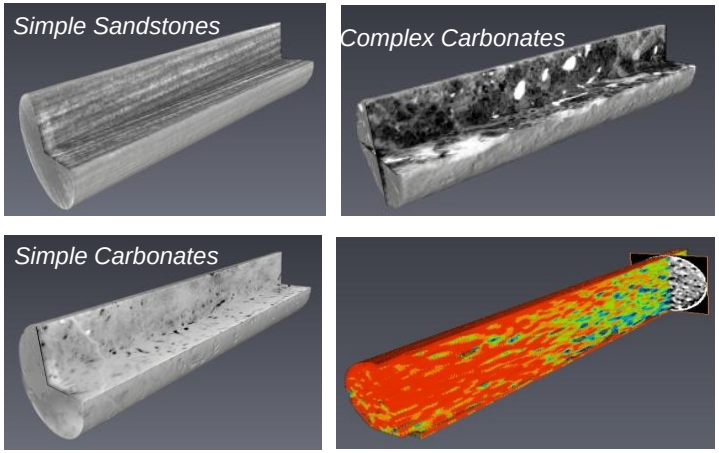

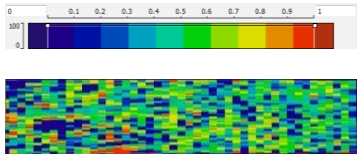

Initial Sw at Sgr

Final Sw at Sgr (after 276 PVI)

Key areas –
Contaminants – CO_2 injected not 100% pure……

Viscous versus capillary dominated flow regimes

Upscaling - Transboundary CO_2 / pressure

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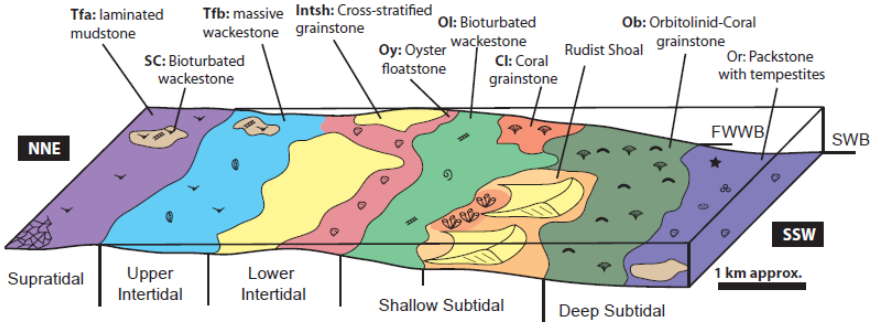
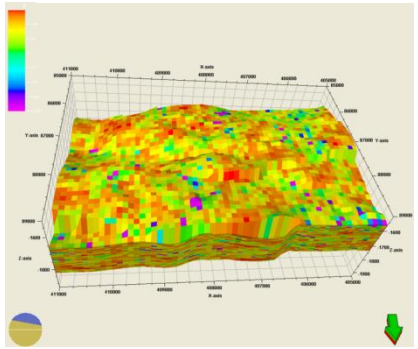
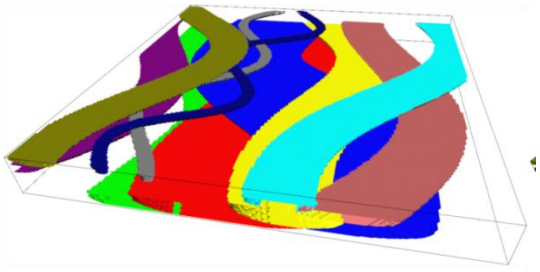
Reservoir simulation

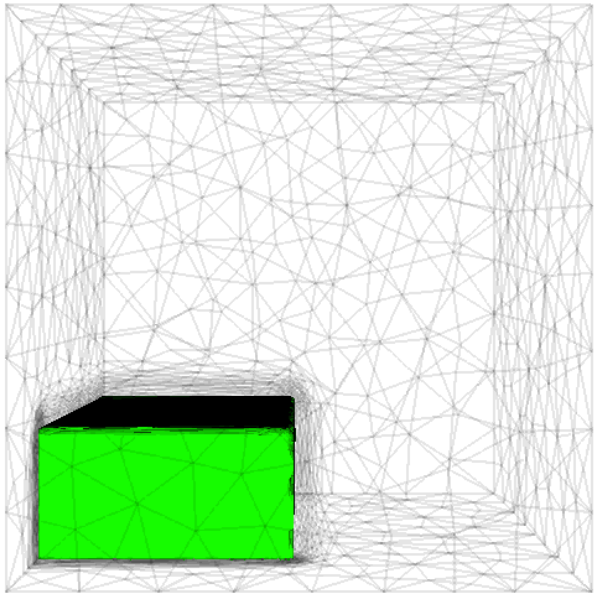
Revisiting traditional grid/block based geological models with specific flow units and developing finite element adaptive meshing incorporating new methods for capturing fractures and new geochemical models.







Reservoir flow units and outcrop models



Fluidity simulation of fluid dropping

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