SCA 2017 – Vienna, Austria

Core Imaging - Short Course
Introduction – Why image cores?

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SOCIETY OF CORE ANALYSTS

Working together for a safer world

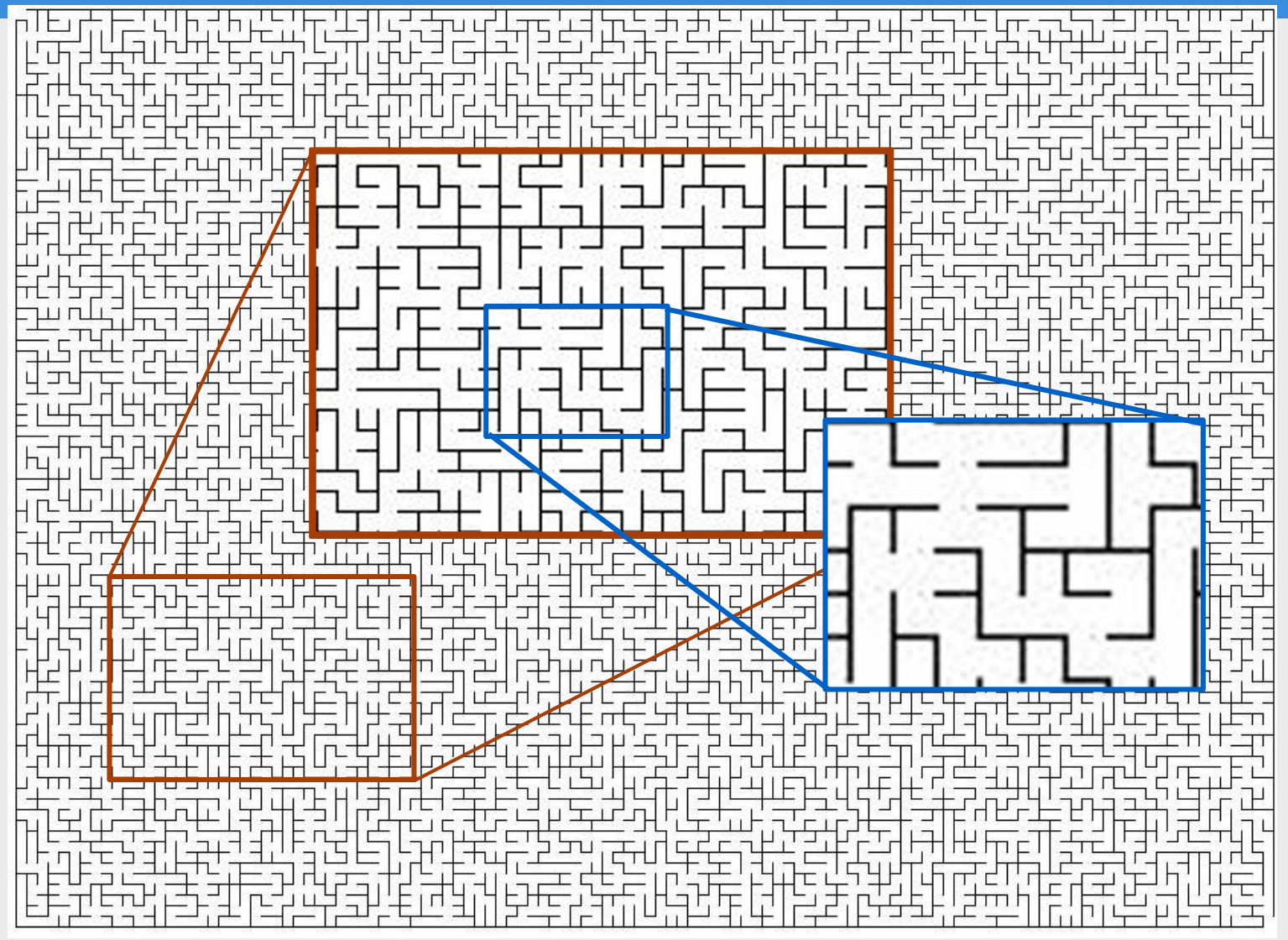
Reasons for core imaging

- Reservoir Characterisation
  - Description, Lithology, Mineralogy, Flow units, Orientation, net pay
- Sample selection – sample heterogeneity
- Program design pitfalls – mineralogy and core prep
- Saturation determination (e.g. SS only viable method)
  - Local fluid saturations
  - Fluid dynamics
- Diagnostics (e.g. formation damage)

Introduction

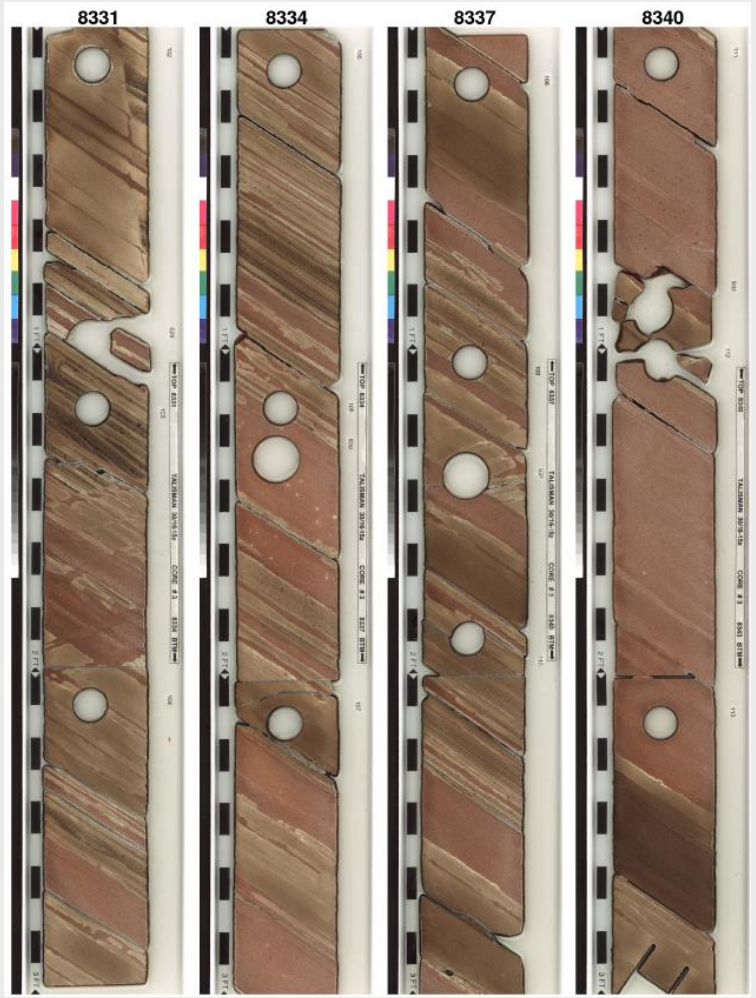
- Core Photography (White light & UV)
  - High resolution photography
- Microscopy (thin section)
- Scanning Electron Microscopy (plus EDX, EDS)
- Infra-red spectroscopy
- X-ray fluorescence, x-ray diffraction
- Gamma / X-ray / CT
- Magnetic - NMR, MRI, magnetic susceptibility

Core Imaging – small sample to represent the whole

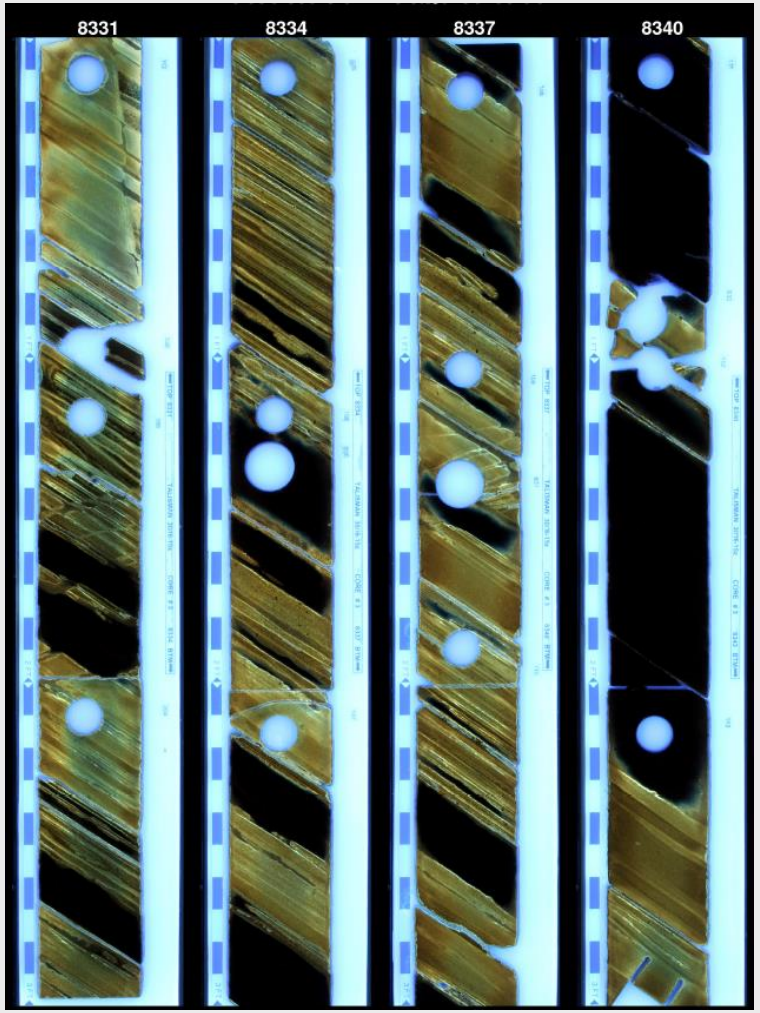


Core Photography

White Light



UV

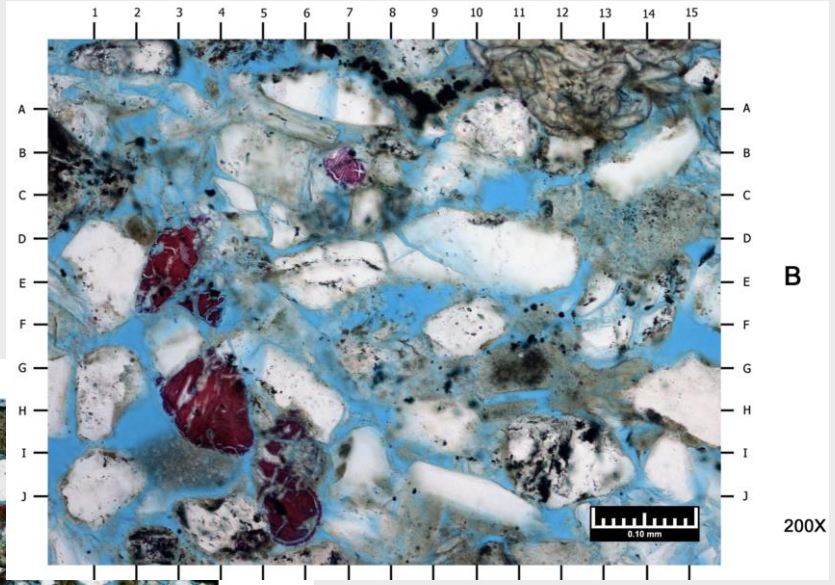


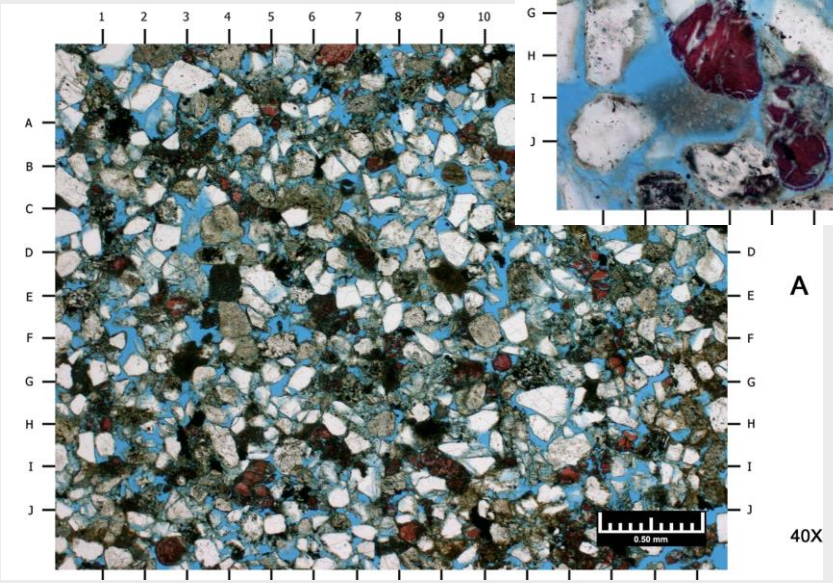
Confirm lithology
Observe HC content (UV)
Differentiate pay zones

Core photography – high resolution

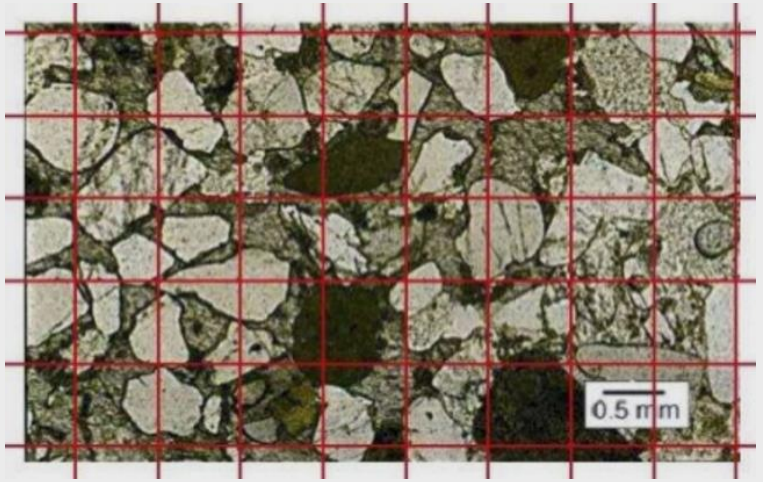
Petrography - Microscopy

- Thin section



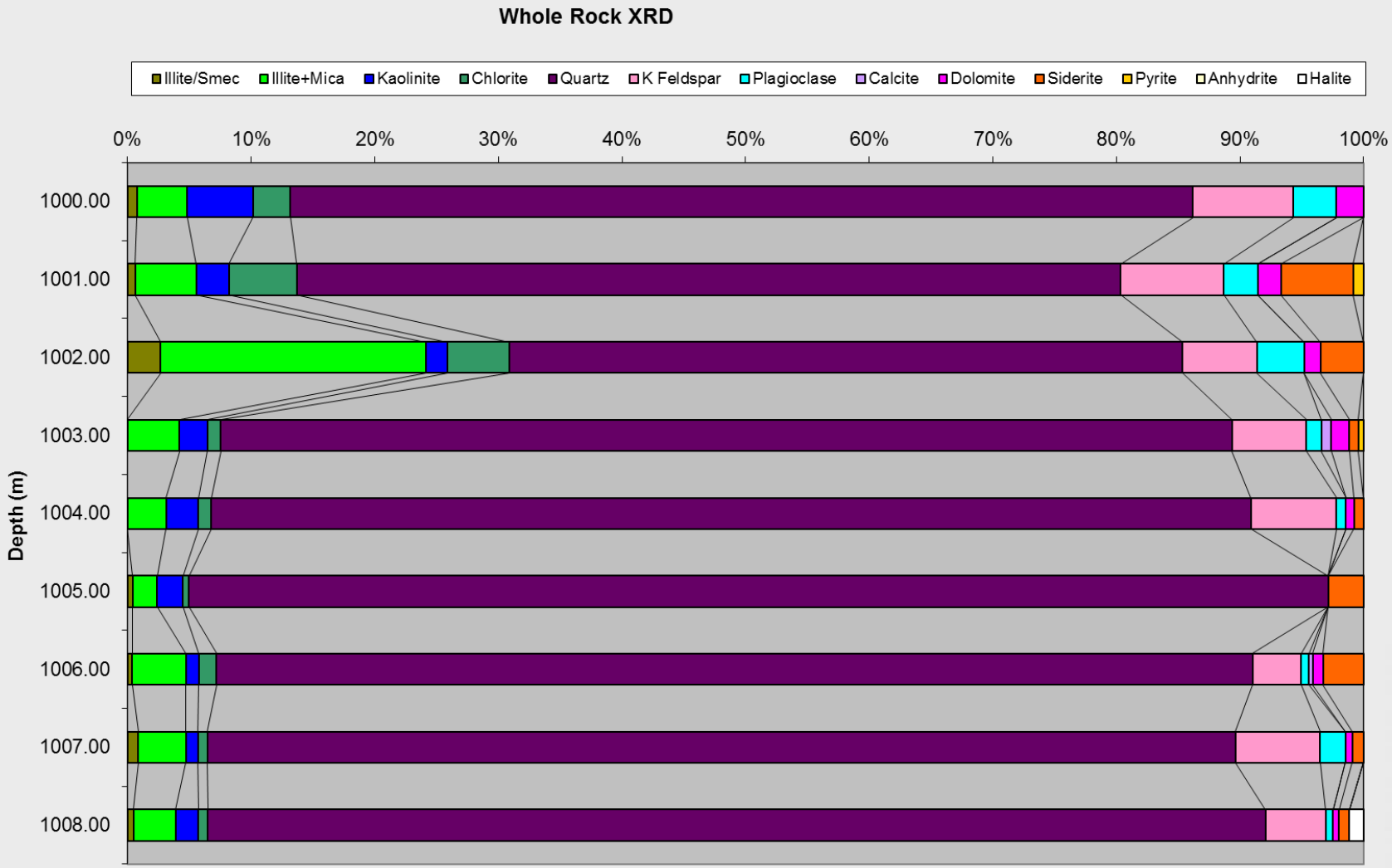


Point count

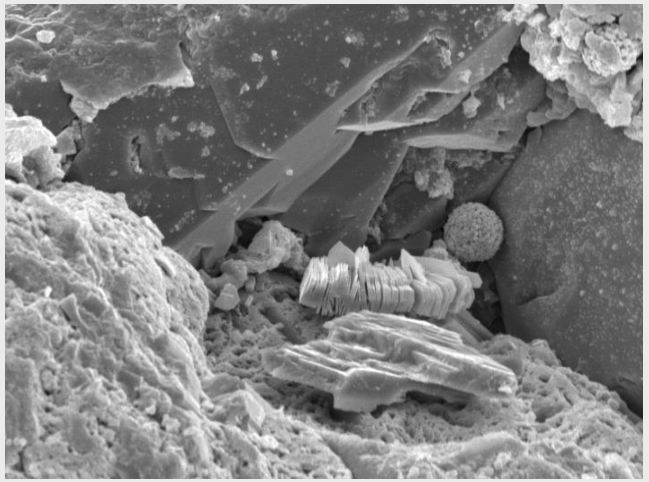


Legacy microscopy technique

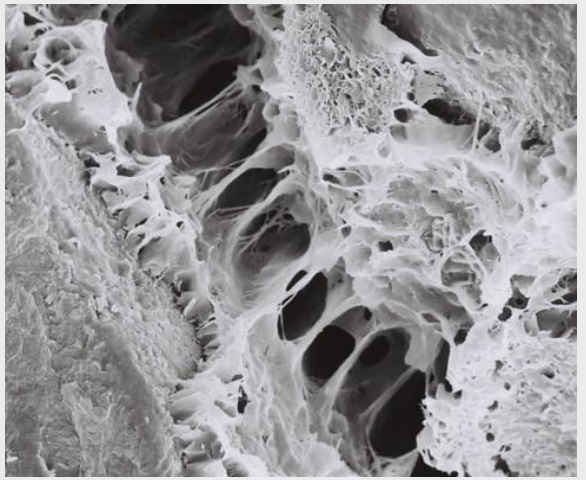
Petrography - XRD



Petrography - Scanning Electron Microscopy (SEM)



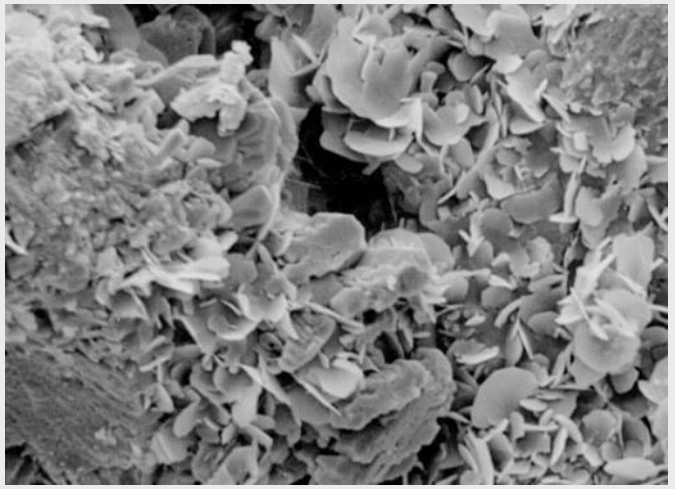
Discrete Kaolinite



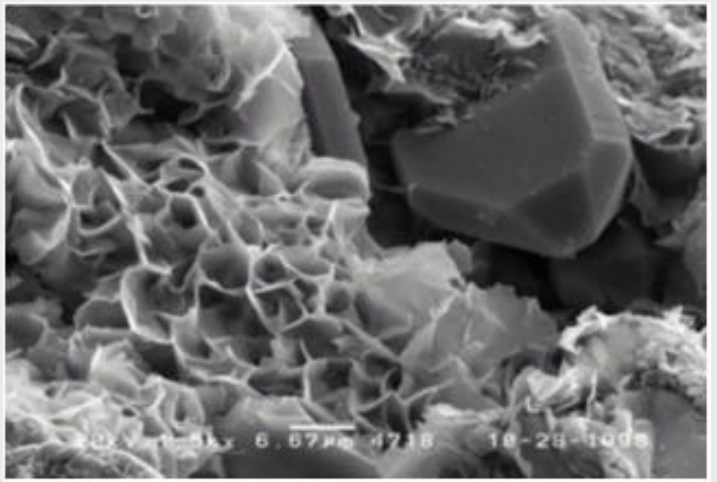
Pore-bridging Illite

Whilst TSA & XRD provide content volumes

SEM shows clay location and morphology

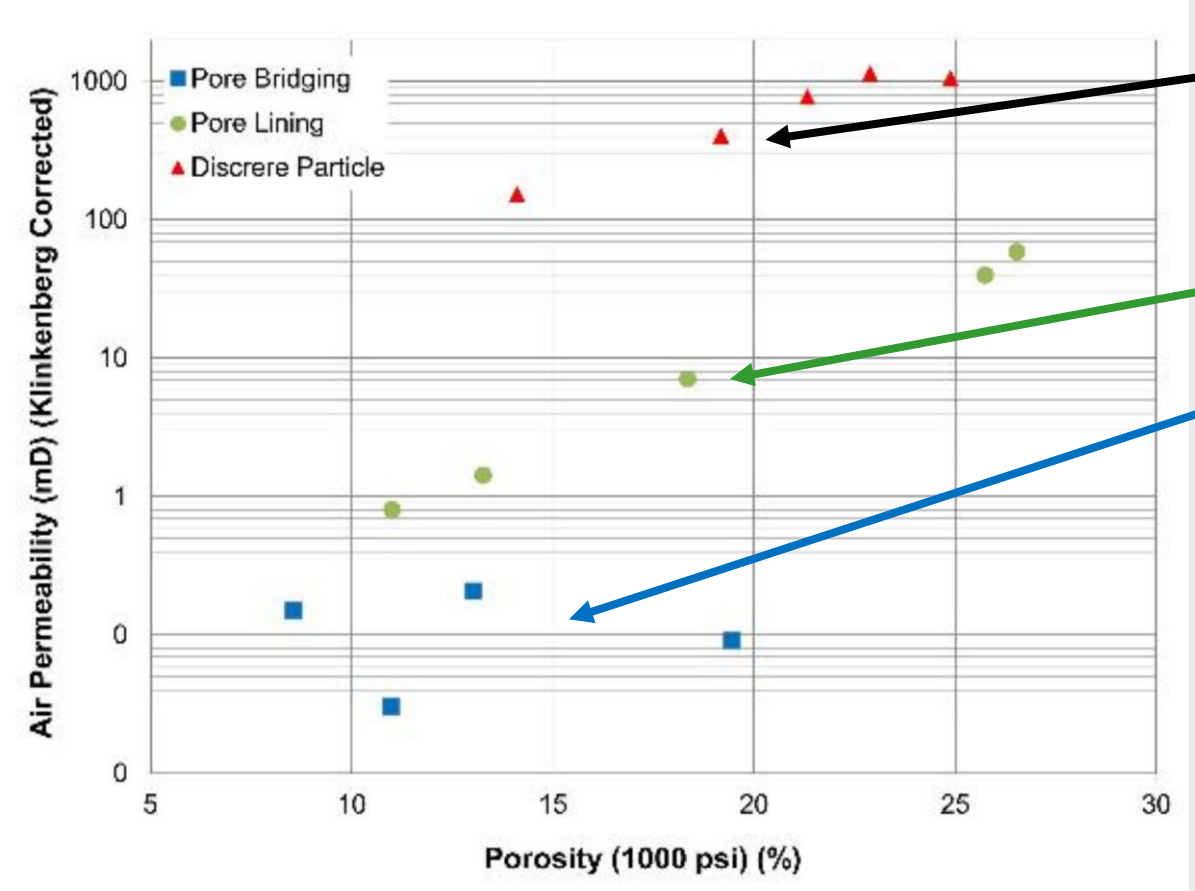


Pore lining Chlorite



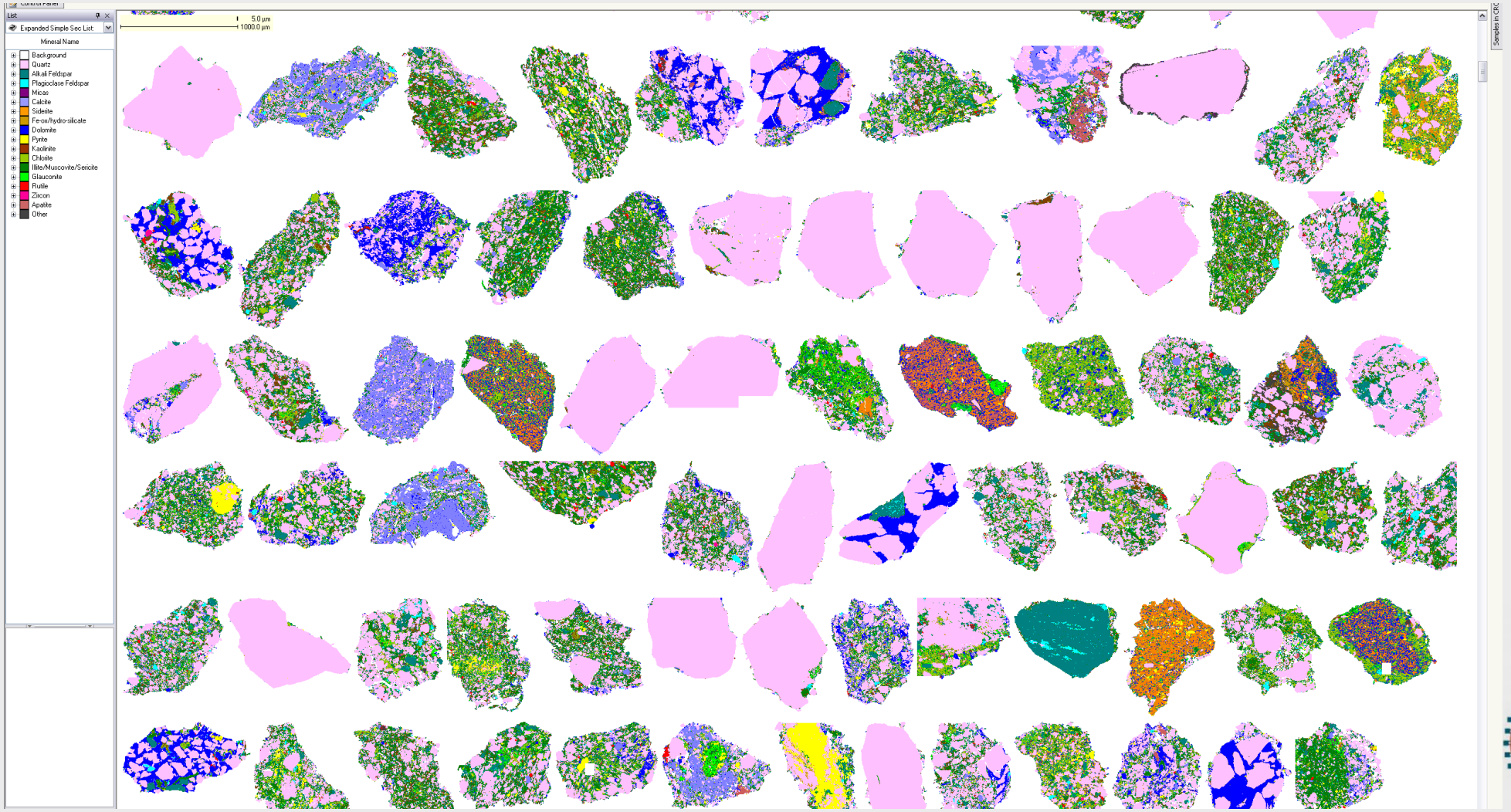
Pore Filling Smectite

Import of clay location and morphology



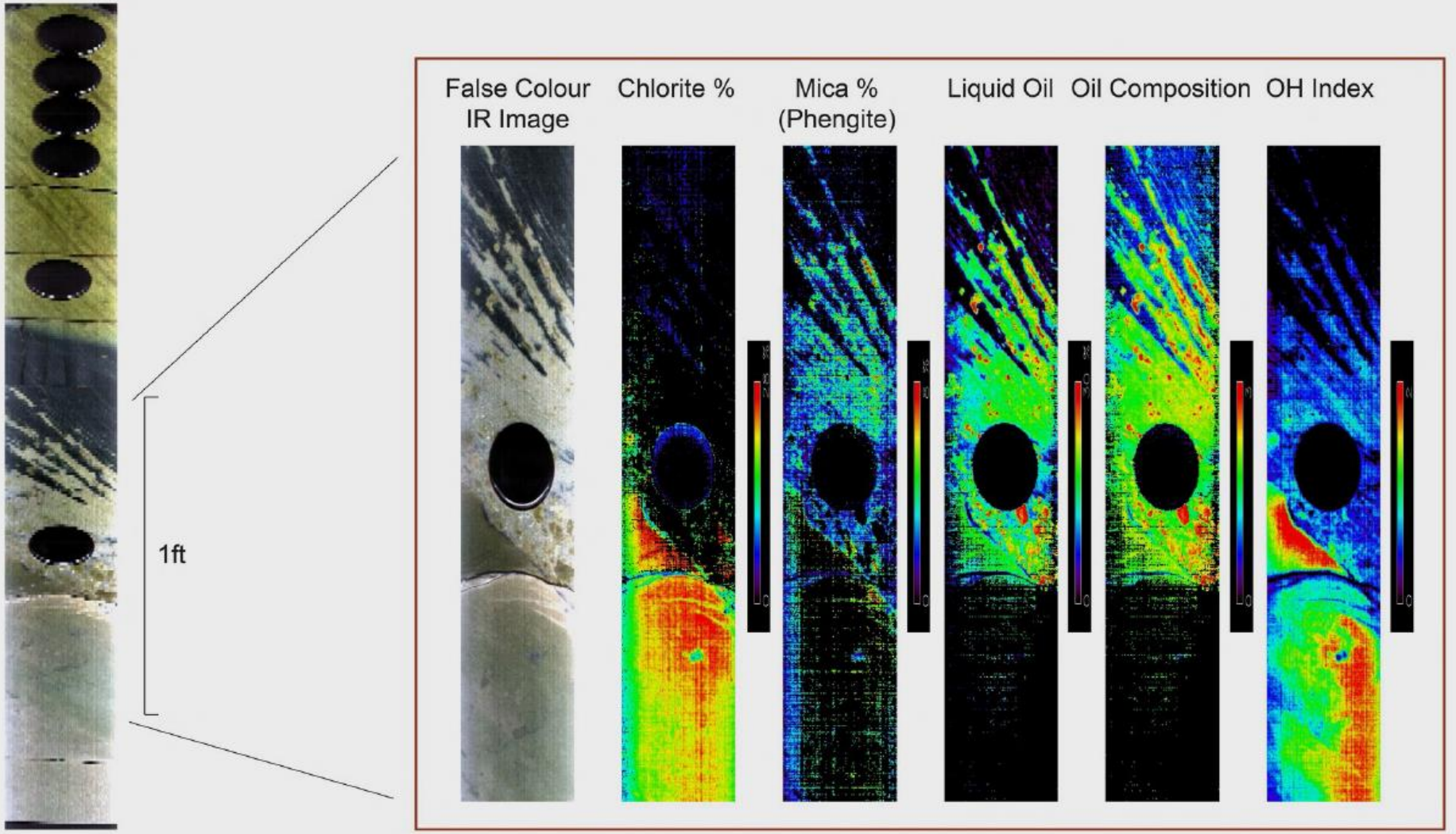
- Discrete Clays
  - little effect on permeability
- Pore lining/bridging
  - reduce pore throat size
  - increase tortuousity
  - reduce permeability
- Clay morphology altered by cleaning/drying

Mineral mapping – drill cuttings



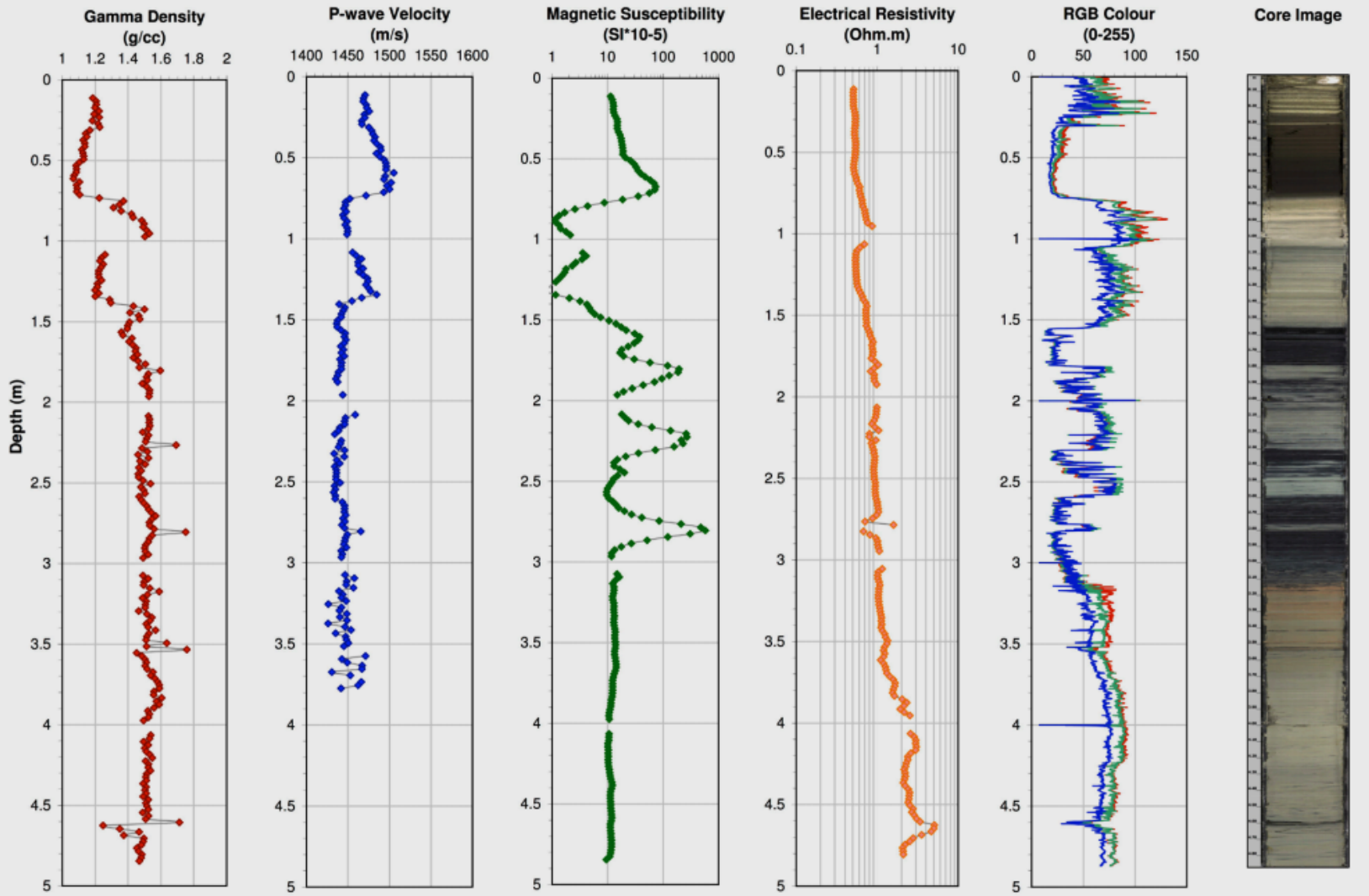
Courtesy QEM-scan

Mineral mapping – whole core



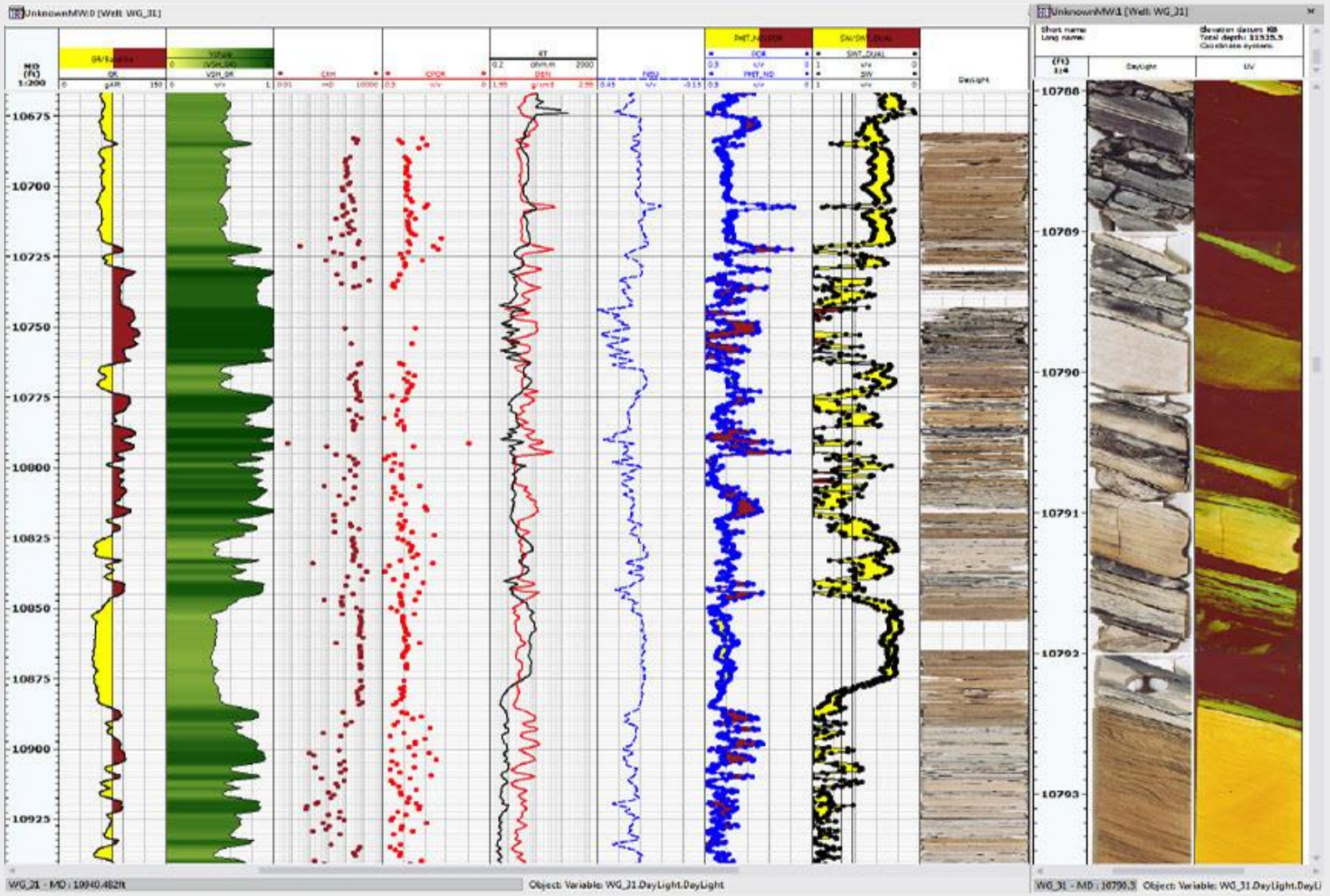
Courtesy Spectra-map

Multi-image tools



Courtesy Geotek Ltd

Combining & correlating to well logs



Courtesy Techlog

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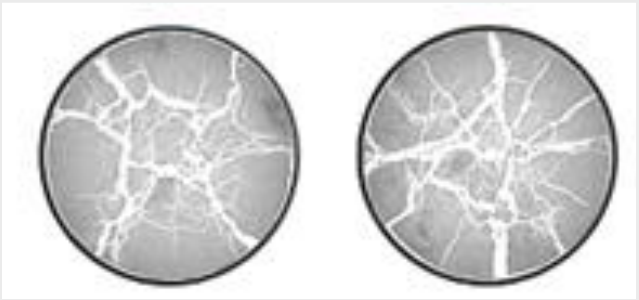
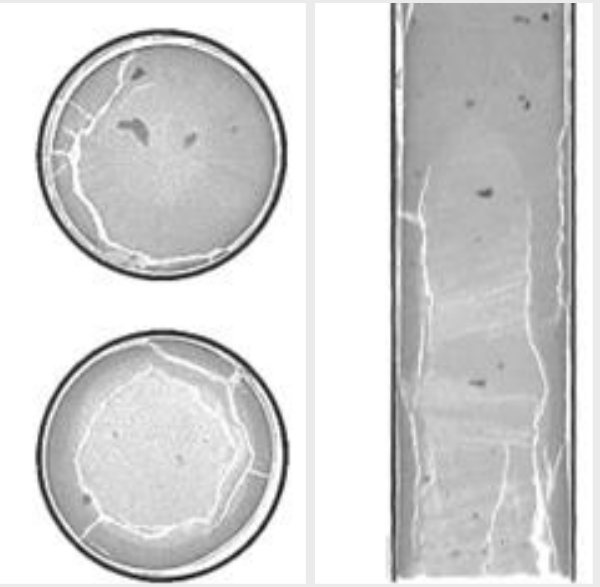
CT scan – damage evaluation

- Essential to understand potential core damage to assess sample selection and evaluate core analysis results
- Limited resolution

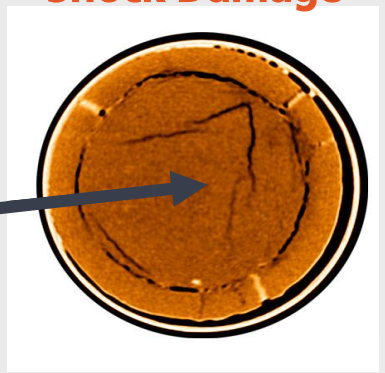
Gas Expansion



Shearing during coring

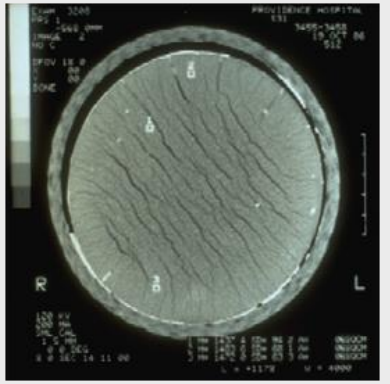


Shock Damage



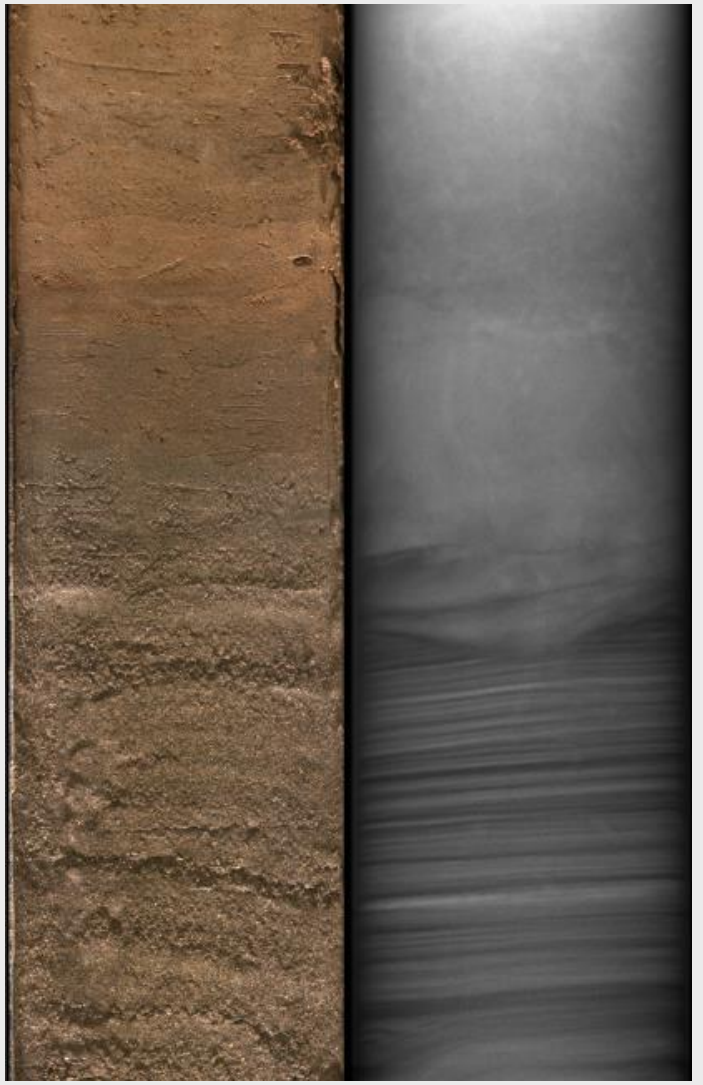
Chevron implies transit/handling damage

Longitudinal Fracturing



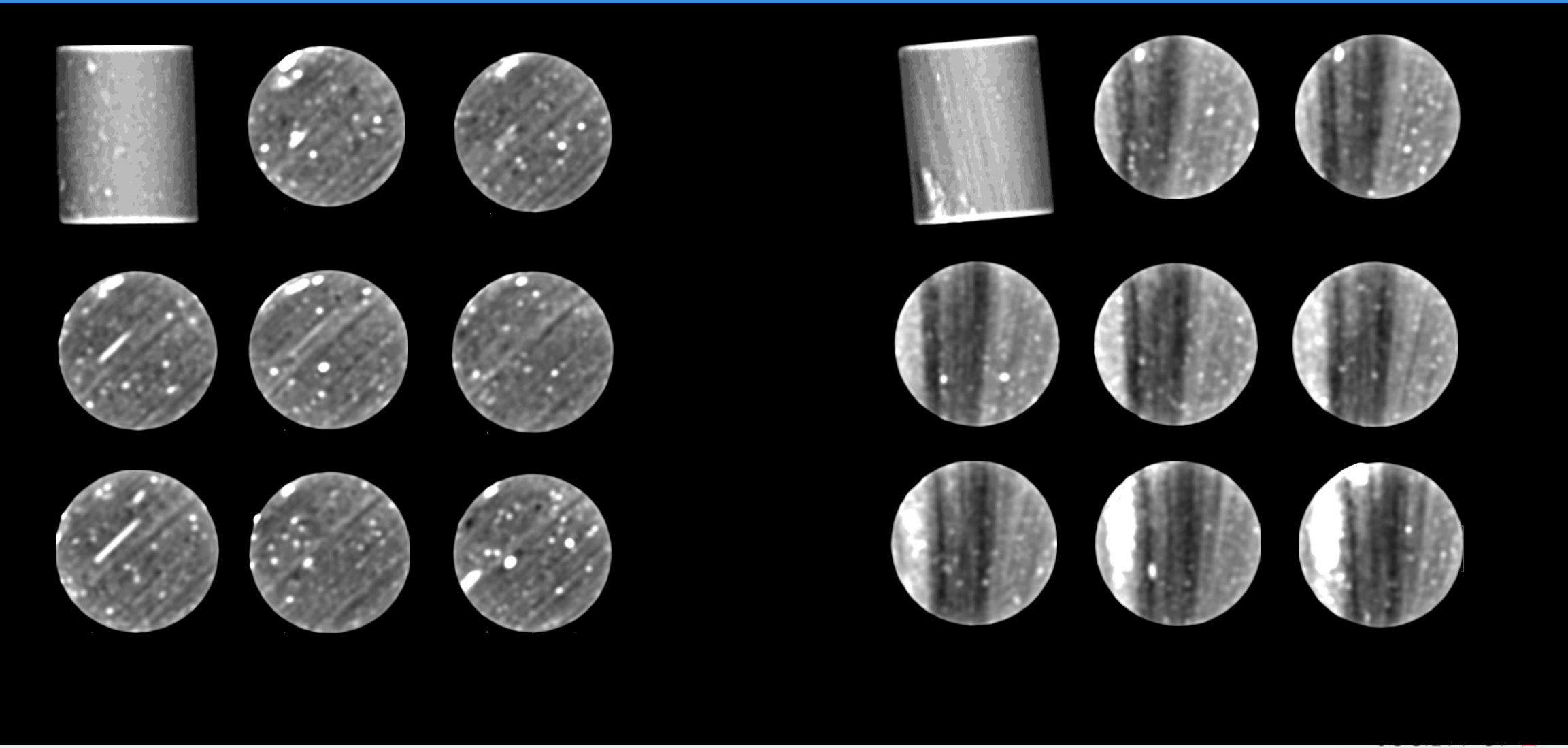
CT scanning – selection/evaluation tool

- To observe visually difficult lithological features
- To observe features before removing core from preservation



CT scanning – selection/evaluation tool – Whole Core

CT scanning – selection/evaluation tool – Core Plugs



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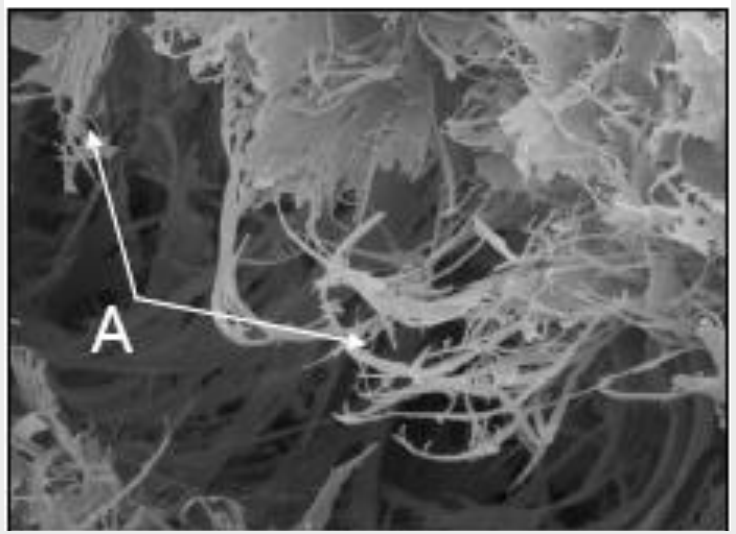
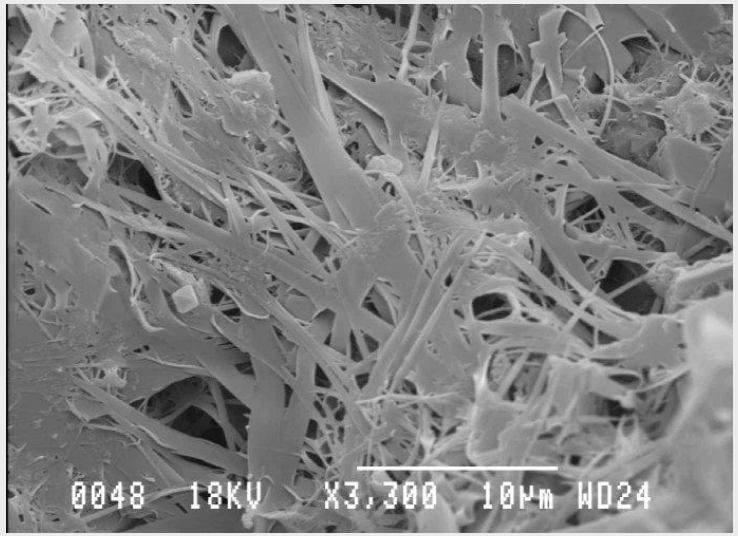
Mineralogy – to aid sample prep / test design





- Excess temperatures/evaporative cycles (hot Soxhlet)
  - Dehydrate/collapse smectite, illite, chlorite
- Methanol can weaken hydroxyl groups between clay layers (particularly kaolinite)
  - High rate flush cleaning
    - fines movement (kaolinite, chlorite & illite)
- Chamosite (Fe^{2+}-rich chlorite) is oil wet

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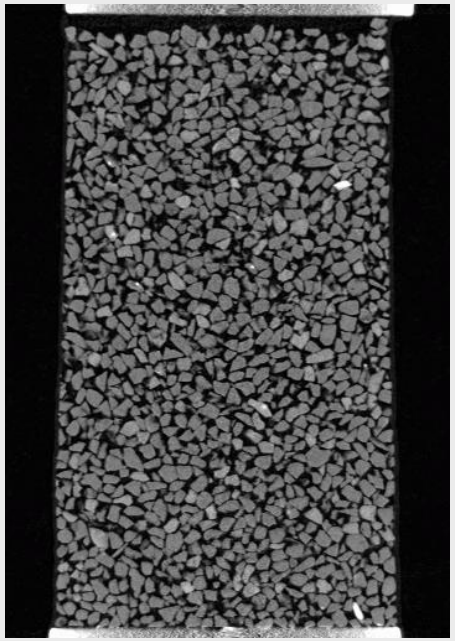
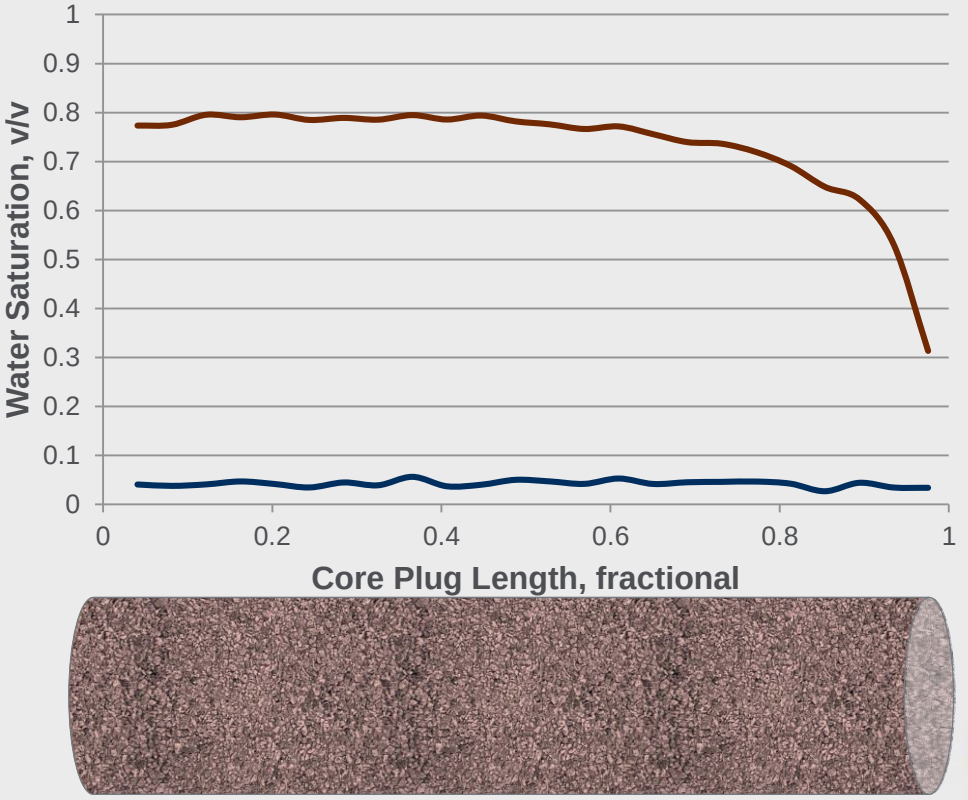
Saturation and other measurements

- Geomechanics properties
- In-situ saturation measurement (ISSM)
- Fluid flow





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Formation damage diagnostics

SEM, in particular, can be used to assess cause of formation damage