Advanced environmental technologies for coal permeability enhancement

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"Unlocking Natural Gas in Tight Coals by Cleat Demineralisation"

Introduction

Tight coals are host to significant gas resources that are largely untapped, mainly due to technical challenges with depth and ultra low permeability ($k \sim nD$ range).

Stimulation of naturally-occurring fractures (cleats) could provide a simple, rapid and readily-available solution for unlocking entrapped natural gas in tight coals.

Methodology

This research project used a combined experimental-computational approach, using actual tight coal cores of interest, core flooding stimulation systems and x-ray μCT–based imagery of specimens-of-interest for digital rock analyses (Figure 1).

Coals of interest were digitised and analysed prior to, during and after experimental stimulation studies. Permeability measurements, in both simulated and experimental runs, were used for assessing stimulation efficacy, and provide sound mechanistic explanation.
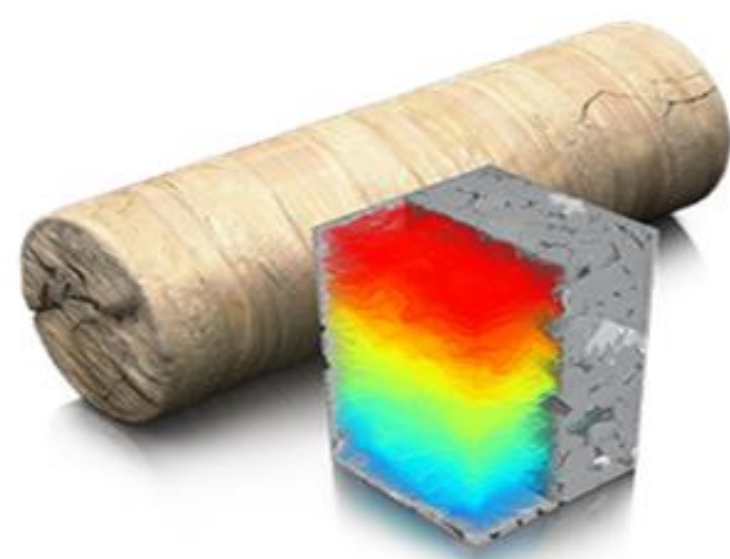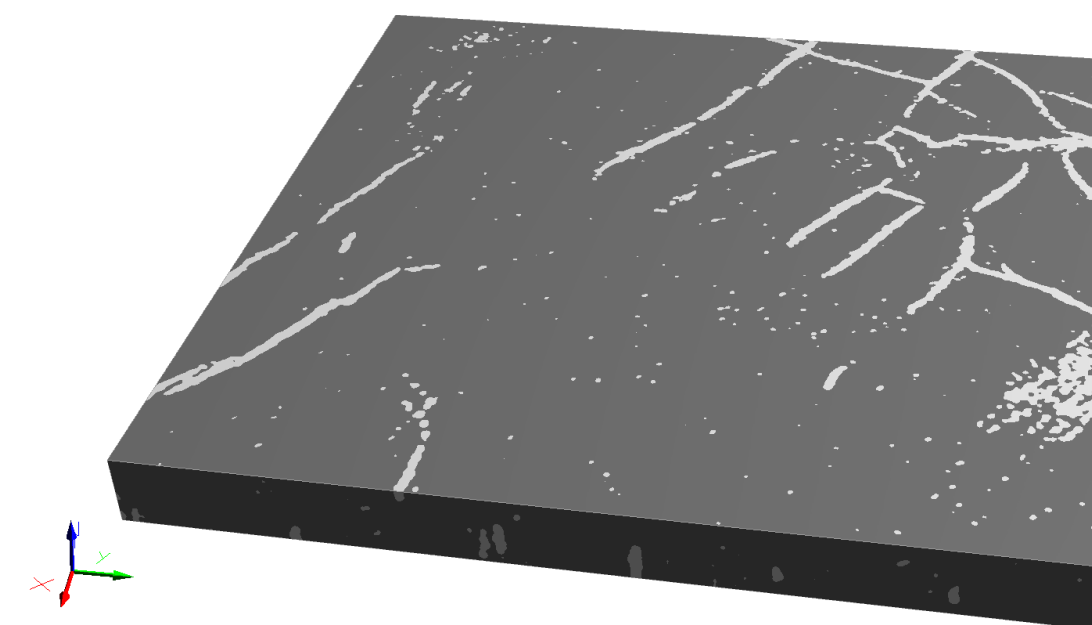

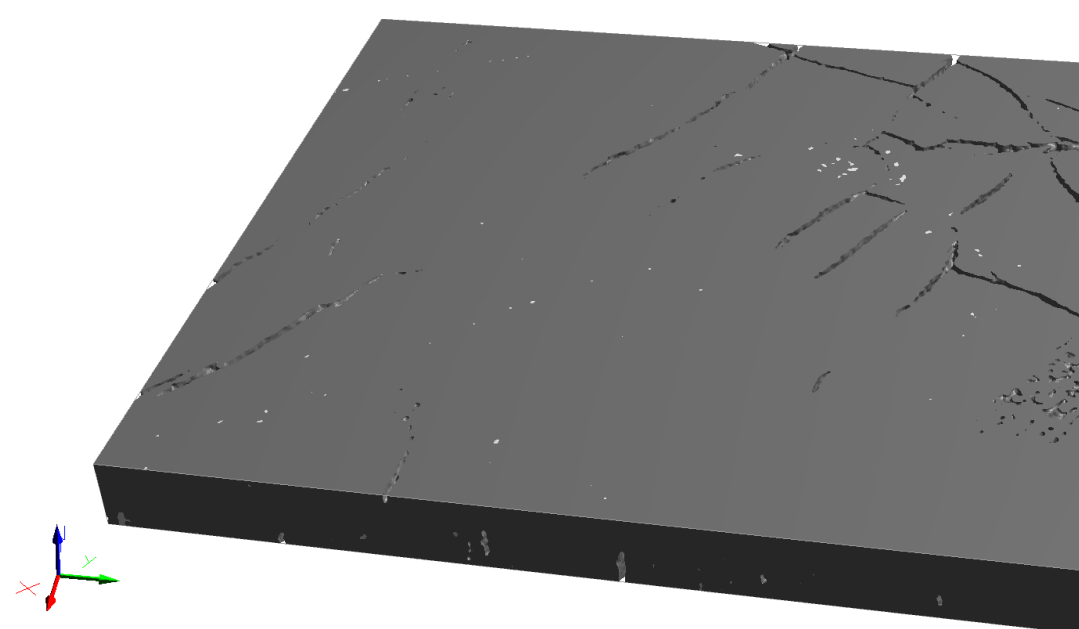*Figure 1: A combined computational-experimental approach - providing advanced solutions to unlock natural gas.*
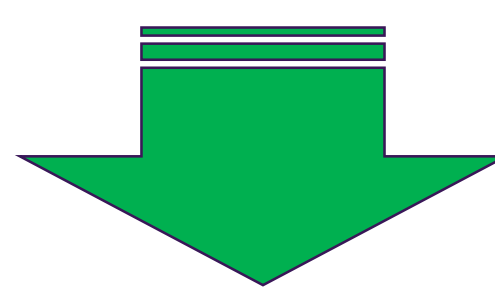
Rock permeability

Permeability was predicted/simulated and measured experimentally

Tight coal

$$k_x, k_y, k_z \sim 1 \text{ nD}$$

Stimulated coal

$$k_x = 216 \text{ mD}$$
$$k_y = 113 \text{ mD}$$
$$k_z = 447 \text{ mD}$$

Digital rock analyses, flow simulation and visualisation

Cleat network mapping and mineral identification (Figure 2) plus the identification of preferred pathways, tortuosity values, path apertures and flow bottlenecks (Figure 3).
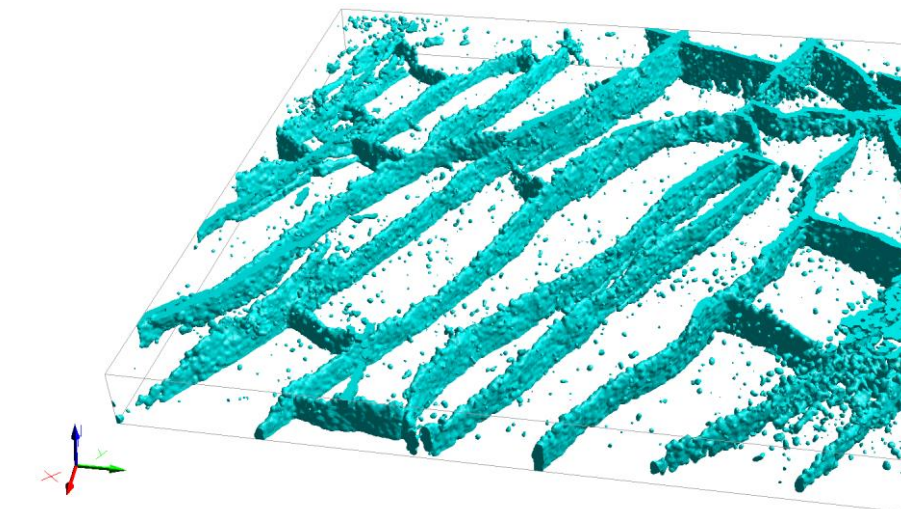

Figure 2: Cleat mapping and mineral ID - Y axis (face cleats), X axis (butt cleats), heavily calcified face and butt cleats.
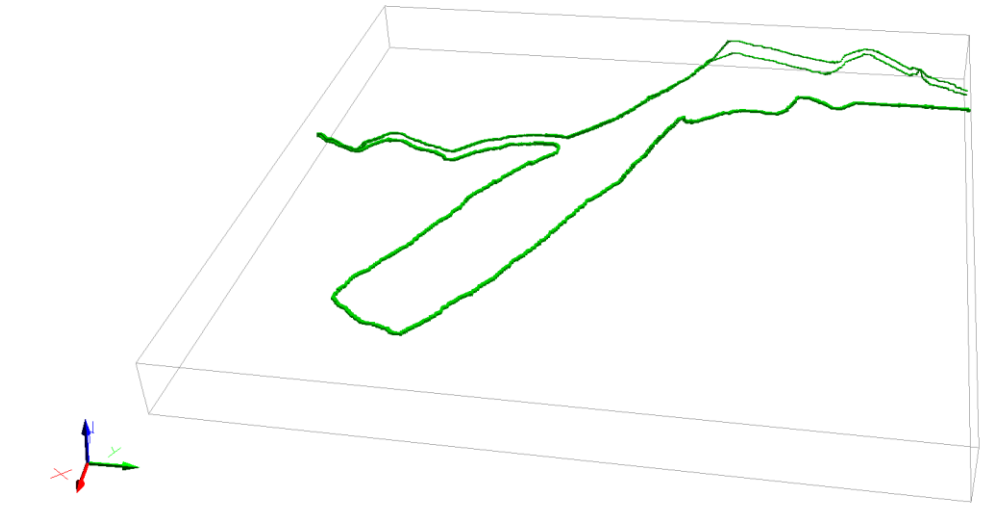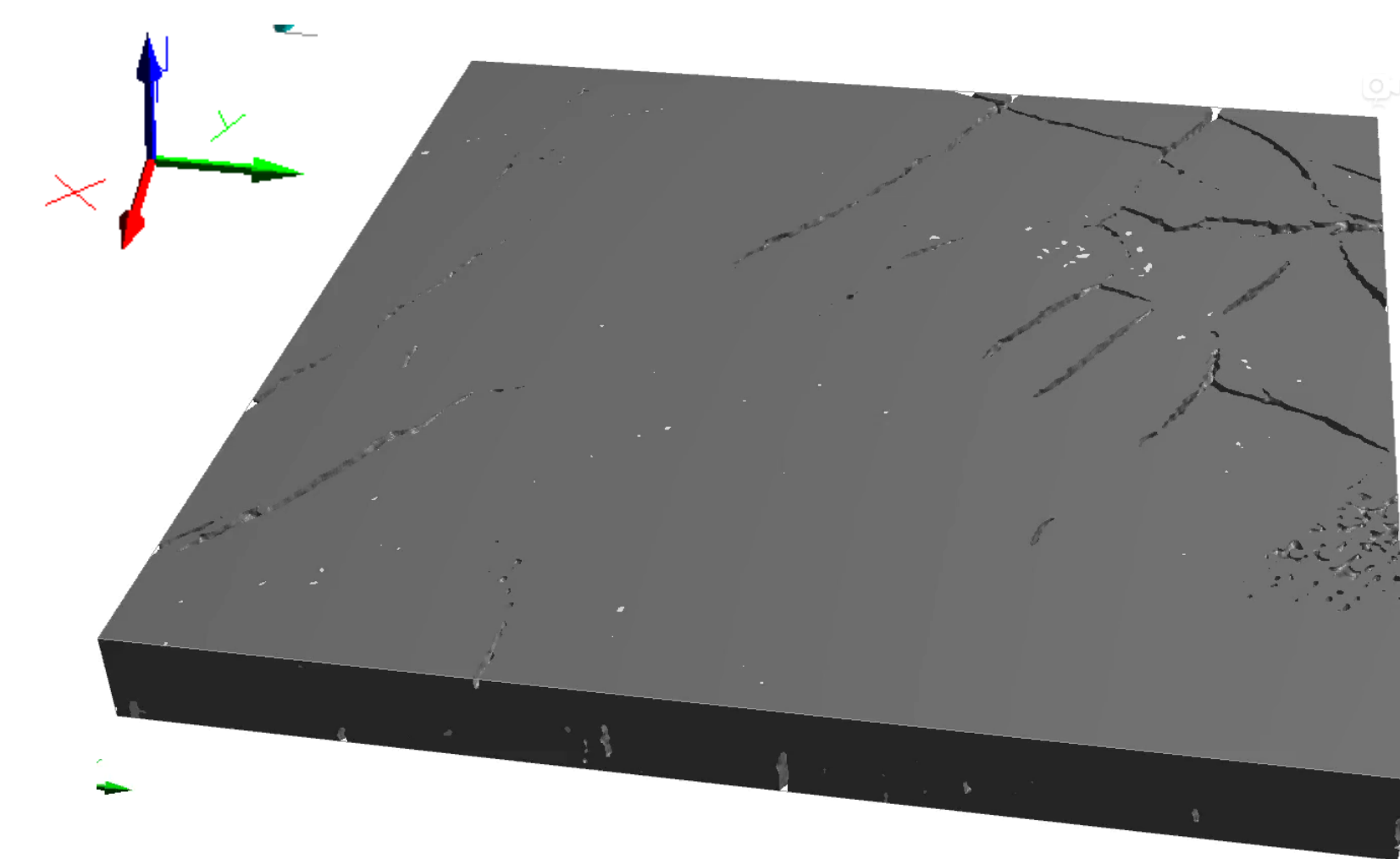
Figure 3: Percolation pathways - Preferential pathways, tortuosity and apertures identified.

Velocity visualisation

Flow simulation as a precursor to permeability prediction