

# Pulsed Arc Electrohydraulic Discharge Stimulation of Coal Seam Interburden for Gas Development

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## Background & Objectives

Interburden is the mixture layer located between the coal measures. Many existing coalbed methane (CBM) wells have already drilled through these undeveloped layers (Fig. 1). However, the potential of coal seam interburden reservoirs (Fig. 2), mainly consisting of mud, clay and organic matter, has not yet been well researched or developed, when compared to that of coal or shale. This project aims to develop and validate an alternative stimulation method to replace traditional fracturing techniques, such as hydraulic fracturing, to effectively crack the thick but malleable mudstone layers without importing any outside chemical fluids into the subsurface or causing clay swelling, to improve the gas recovery from CBM wells.

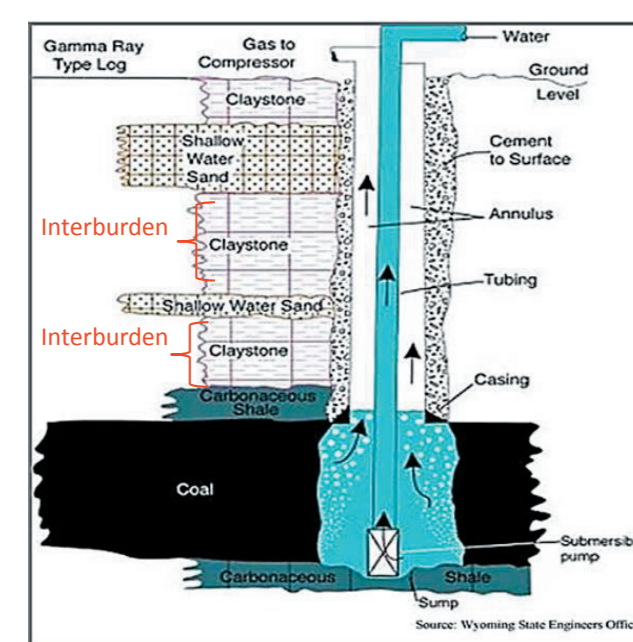


Fig. 1 Schematic of a coalbed methane well

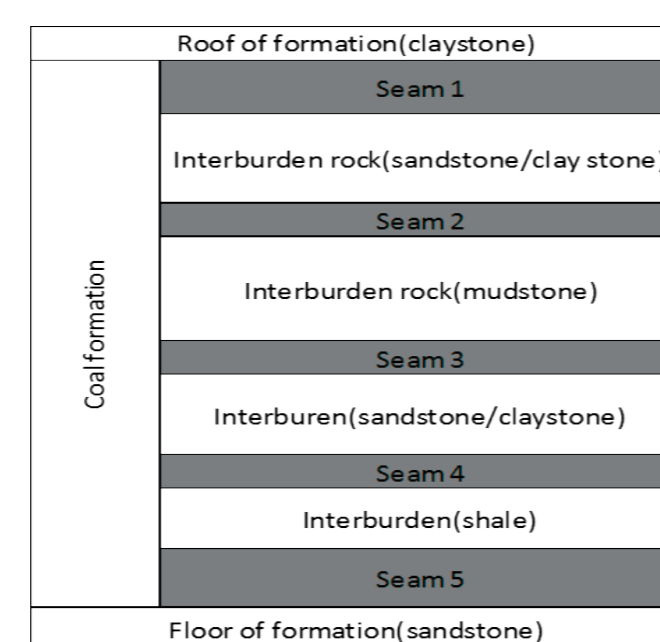


Fig. 2 A typical layout of coal formation

The project is structured around the following objectives:

- Experimentally measure the coal seam interburden properties relevant to gas development
- Develop pulsed arc electrohydraulic discharge (PAED) and employ it to enhance/improve interburden permeability
- Understand the mechanism of interburden breakage by PAED and simulate the multiphysics coupling using finite element method

## Properties of Coal Seam Interburden

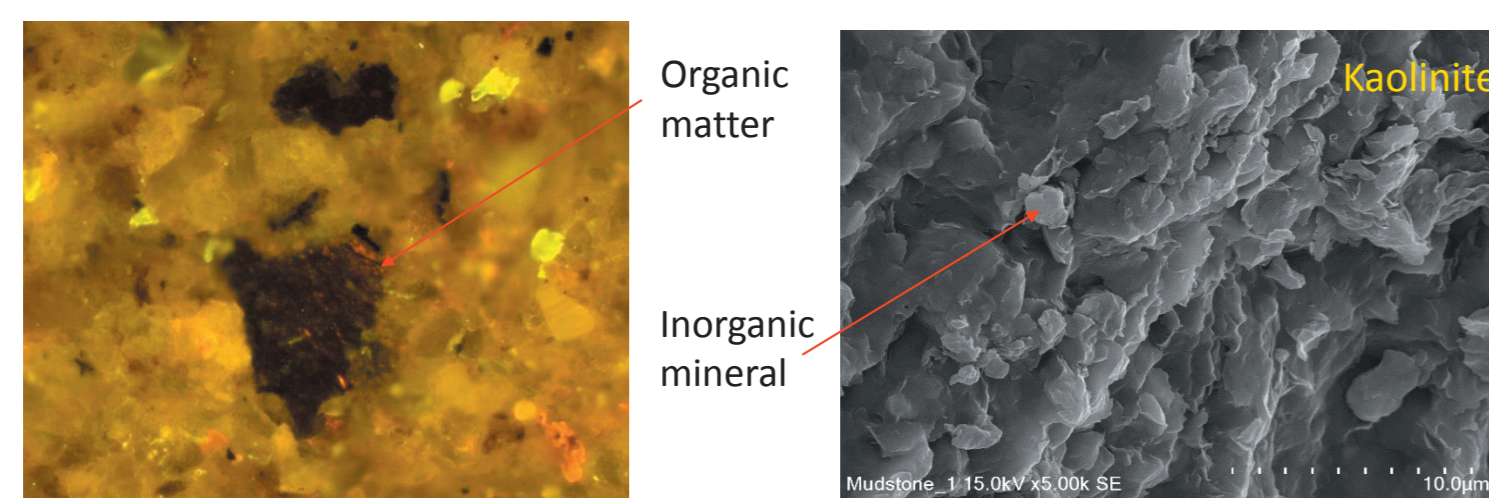


Fig. 3 Microscopy and SEM of interburden sample from Surat Basin

1. Interburden mainly consists of clay mineral and organic matter which are relevant to its pore structure and gas adsorption ability
2. The mechanical strength of interburden affects the PAED stimulation design and parameter settings

## Experimental Setup for PAED Stimulation

Develop and employ PAED stimulation technique to crack the interburden specimens at the lab scale. The schematic of PAED setup is shown in Fig. 4

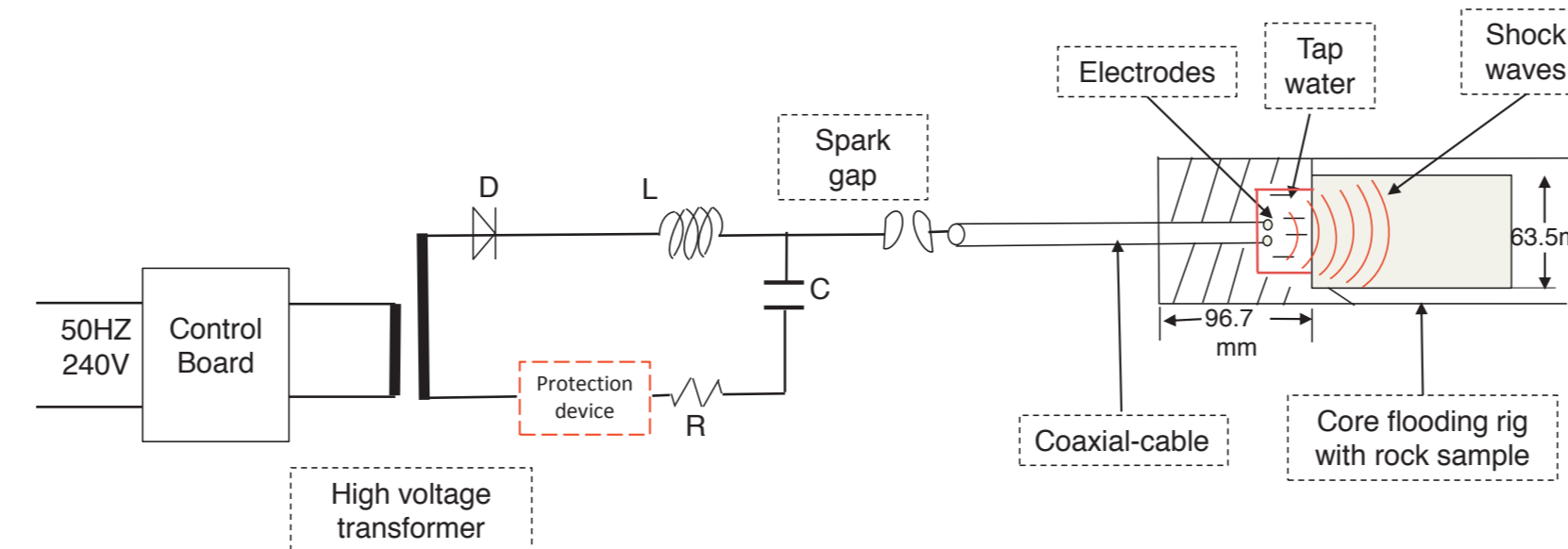


Fig. 4 Schematic of PAED setup for interburden stimulation

The rationale of PAED stimulation is that two underwater copper electrodes are connected with a set of capacitor banks charged with a high voltage. When the circuit is switched on, a plasma is generated between the electrodes reaching temperatures of thousands of K, resulting in a compressive pressure pulse, the strong pulse/shockwave will propagate in the water and crack the interburden specimen nearby (Fig. 5).



Fig. 5 Photograph of PAED testing setup

### Parameter settings for testing

- Shockwave generation:**
- Charging voltage: 20 ~60 KV
  - Capacitance: 2 ~ 12 uF
  - Discharging period: nanoseconds ~ 70 us
  - Pulse number: adjustable
  - Electrodes gap: 5 mm
- Permeability measurement:**
- Confining pressure: 20 bar
  - Inlet pressure : 2 bar
  - Outlet pressure : atmosphere

## Testing Sample Information

In the current stage, to explore and summarize the most efficient discharging circuit and parameter settings for strong shock wave fracking, preliminary tests on homogeneous mortar sample and identified coal sample were carried out.

The testing specimens here are C2 mortar with the compressive strength of approx. 6 MPa, Gluluguba-2 Coal from Surat Basin



Fig. 6 Testing mortar samples made in lab

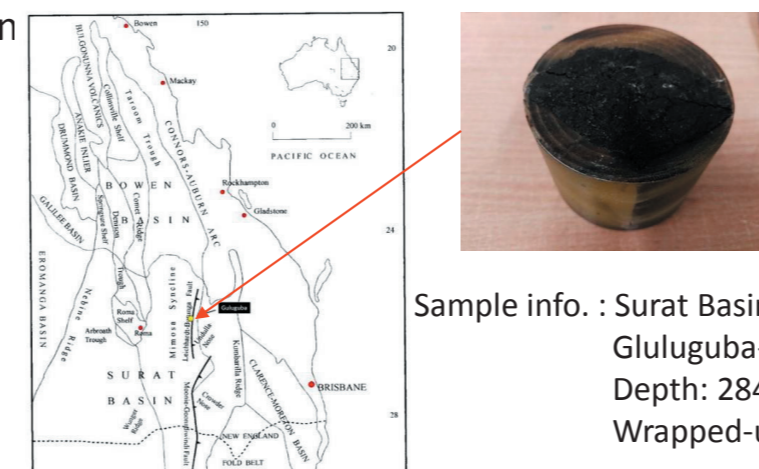


Fig. 7 Gluluguba-2 coal from Surat Basin

## Results

After the stimulation on C2 by PAED (Fig. 6), the permeability (Fig. 8) and porosity (Fig. 9) of testing C2 mortar specimen have both increased due to the impact of shock waves.

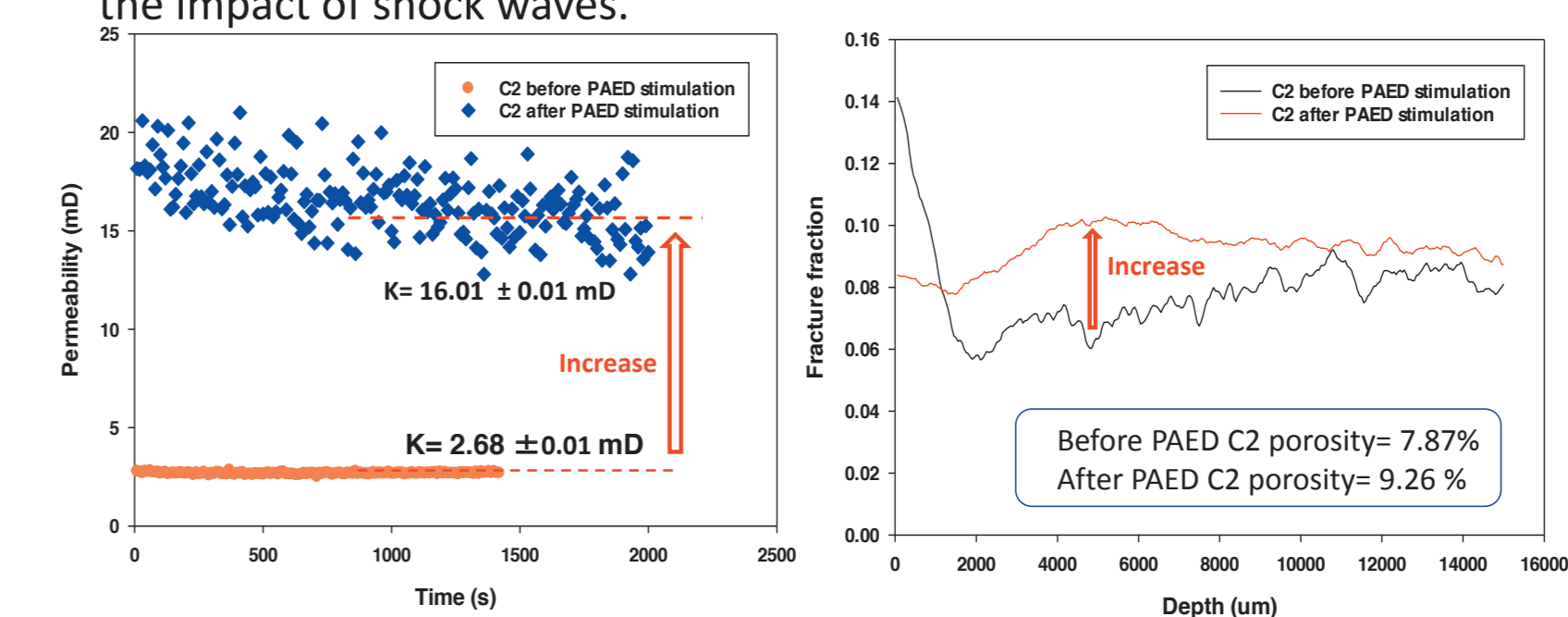


Fig. 8 C2 permeability before and after PAED stimulation

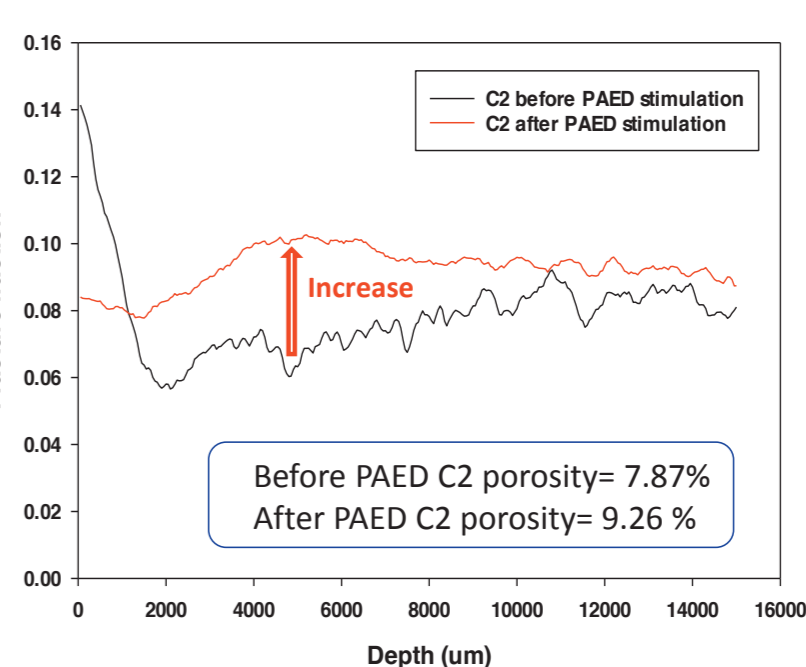


Fig. 9 C2 porosity before and after PAED stimulation based on CT image

The CT scanning was utilized to analyse the fracture and void evolution before and after PAED stimulation on Gluluguba-2 coal (Fig. 7).

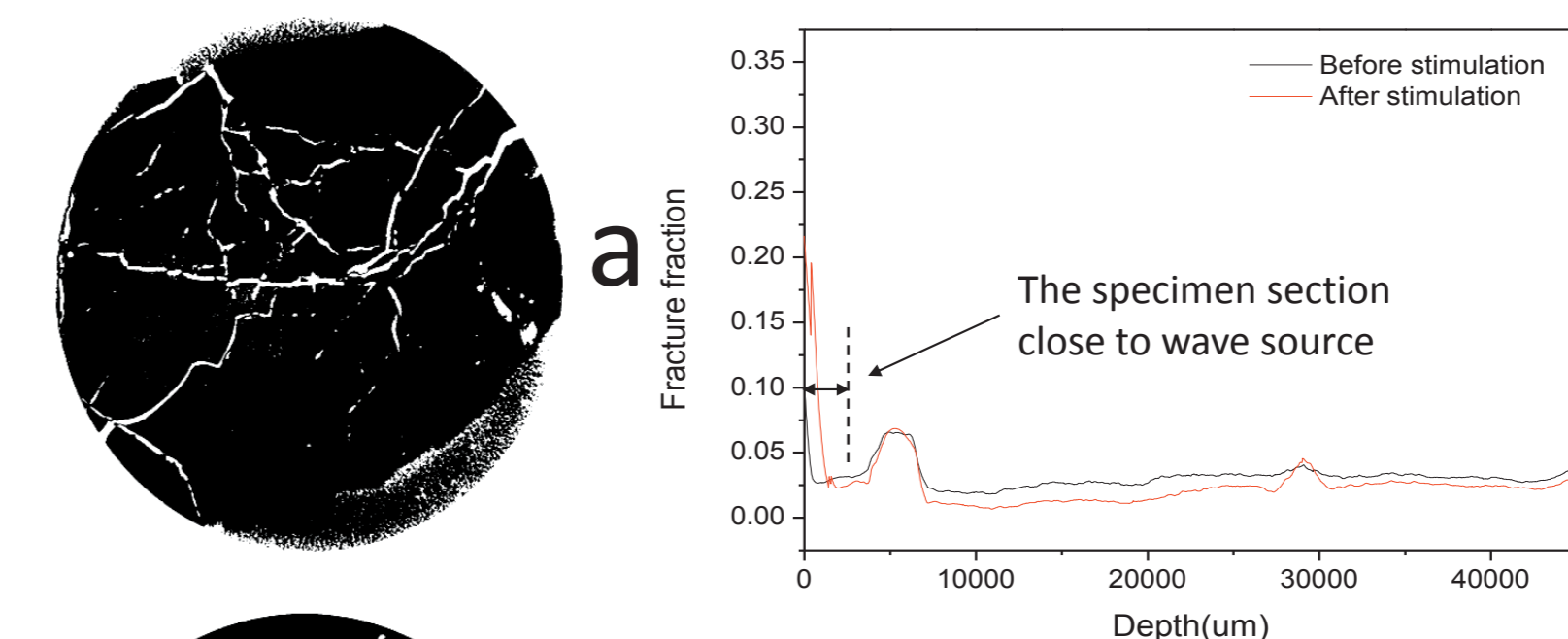


Fig. 10 CT image thresholding at the stimulation side of the coal core sample before (a) and after (b) stimulation (white: pores)

The fracture and void of coal specimen after PAED stimulation have improved (Fig. 10), particularly the front part which is close to the shockwave source (Fig. 11).

## Acknowledgement & References

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2. SAGHAFI A. et al. 2010. Parameters affecting coal seam gas escape through floor and roof strata. *2010 Underground Coal Operators' Conference*: 210-216.