



FRACLAB

Hydraulic Fracture Test System

Rock-mechanics testing platform for hydraulic fracturing, triaxial compression and acoustic emission monitoring under high pressure and elevated temperature.

ROCK MECHANICS

HYDRAULIC FRACTURING

AE MONITORING

AT A GLANCE

| | |
|------------------------|---------------------------|
| Confining pressure | 70 MPa |
| Axial stress | 424 MPa |
| Pore / fracturing | 70 MPa |
| Temperature | 150 °C |
| Specimen \varnothing | 54.7 mm |
| AE channels | 6 lateral, 16-bit |
| Pumps | 4 servo-controlled |
| Standards | ASTM-compliant |



System Overview

A complete platform for rock-mechanics and hydraulic-fracture testing

The FRACLAB system performs hydraulic fracture experiments with microseismic activity monitoring under various triaxial stress states and elevated temperatures. The unified platform combines a high-pressure triaxial cell, four servo-controlled syringe pumps, an 8-channel acoustic emission monitoring module and a real-time supervision station — delivering full mechanical, hydraulic and microseismic characterization of rock specimens in a single, automated experiment.

KEY CAPABILITIES

- ◆ Hydraulic fracturing under triaxial stress
- ◆ Breakdown pressure & tensile-strength measurement
- ◆ Rock triaxial compression test (UCS / CTC)
- ◆ Rock compressibility & permeability tests
- ◆ Pore-pressure regulation (drained & undrained)
- ◆ Axial & radial strain monitoring (LVDTs + extensometer)
- ◆ Acoustic Emission (AE) event localization
- ◆ Real-time fracture morphology reconstruction
- ◆ Fully automated, servo-controlled testing
- ◆ Standardized report generation



70

MPa

Confining

424

MPa

Axial

150

°C

Temperature

ENGINEERED FOR PRECISION

A pressure-balanced triaxial design isolates the deviatoric piston from confining pressure, delivering parasitic-free axial-stress measurement and ASTM-compliant stress paths — essential for accurate strength, compressibility and fracture-initiation results.

Three Possible Tests

One platform — three complementary measurement modes

FRACLAB combines three coordinated test modes that share the same triaxial cell, instrumentation and control software. Tests can be run independently or sequenced in a single experiment to extract a complete mechanical, hydraulic and microseismic dataset from one specimen.

01

BREAKDOWN PRESSURE

Hydraulic fracturing experiment on a specimen drilled with an axial borehole. Fracturing fluid is injected at constant flow rate until breakdown occurs; tensile strength and frac-coefficient are then computed from the pressure–time curve.

MEASUREMENTS

Fracturing-fluid pressure • Fracturing-fluid flow rate • Pore pressure • Axial & radial stress • Temperature

02

AE MONITORING

Detection and localization of microcracking and fracture events under triaxial loading using six lateral acoustic-emission sensors. Real-time 3D event localization reconstructs the fracture morphology as damage accumulates.

MEASUREMENTS

AE activity & hit counts • AE energy & amplitude • Event duration • Hypocenter localization (≈ 2 mm) • Fracture morphology

03

STRESS-STRAIN

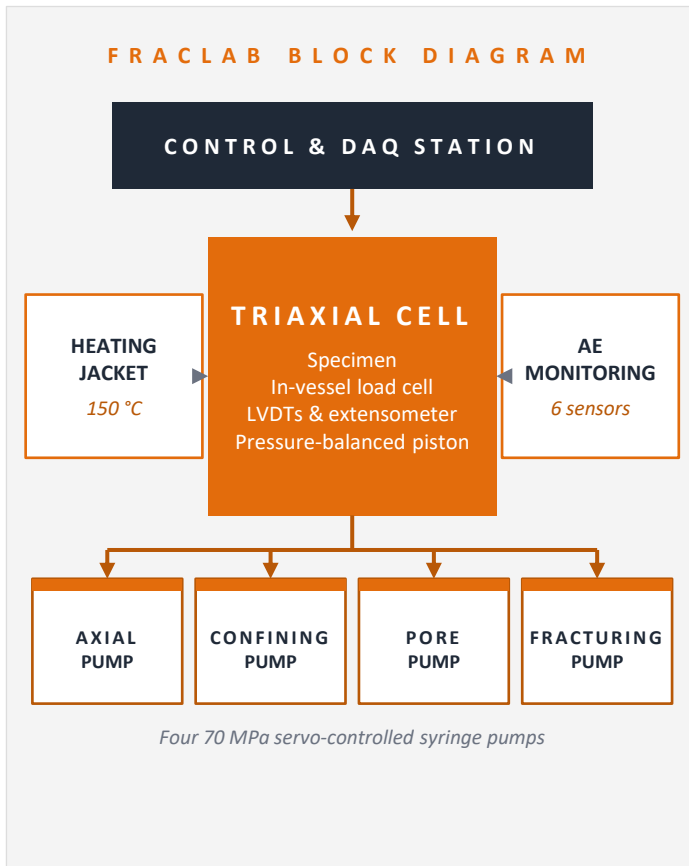
Triaxial compression test with precise measurement of axial and radial strain under controlled confining and pore pressure. Delivers full mechanical characterization including elastic moduli, strength envelope and post-peak behaviour.

MEASUREMENTS

Axial strain (3 LVDTs) • Radial strain (2 extensometers) • Axial load (in-vessel cell) • Confining pressure • Temperature

Main Components

Ten core modules forming the FRACLAB platform



System block diagram — main signal & fluid paths

- 1 Triaxial cell
- 2 In-vessel load cell
- 3 Axial & diametral strain sensors
- 4 Acoustic Emission monitoring system
- 5 Heating jacket
- 6 Triaxial cell hydraulic lift
- 7 Axial pressure pump
- 8 Confining pressure pump
- 9 Pore pressure pump
- 10 Fracturing fluid pump

+ Computer control & data-acquisition station

INTEGRATED ARCHITECTURE

MECHANICAL LOADING

A hydraulically powered loading frame applies axial stress through an in-vessel piston, while the cell base supports the triaxial chamber. A motorized hydraulic lift opens and closes the cell for rapid specimen change.

FLUID CONTROL

Four independent BT-series syringe pumps regulate confining, axial, pore and fracturing-fluid pressures up to 70 MPa with sub-mL/min resolution, supporting drained, undrained and reactive-fluid protocols.

INSTRUMENTATION

Axial LVDTs, a diametral extensometer, an in-vessel load cell, six AE sensors and dual feedthrough connectors deliver simultaneous mechanical, hydraulic and microseismic data acquisition.

Pressure-Balanced Deviatoric Piston

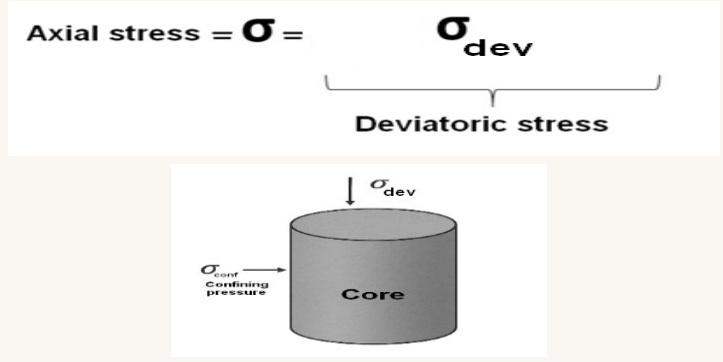
Independent control of axial and confining stress, free of parasitic forces

FRACLAB uses a pressure-balanced deviatoric triaxial cell engineered to apply axial stress (σ_{axial}) and confining stress ($\sigma_{confining}$) independently — while preventing the confining pressure from influencing the measured axial load. This design is the cornerstone of accurate stress-path testing.

HOW IT WORKS

The cell incorporates a pressure-balanced piston, where the confining pressure acts on equal and opposing surface areas. As a result, no parasitic force is transmitted to the load train.

Only the applied axial stress contributes to the deviatoric stress (σ_{dev}), allowing precise and independent control of σ_{dev} and $\sigma_{confining}$ throughout the experiment — even at high confining pressure.



Cell components — assembled & cross-section views

BENEFITS OF THE PRESSURE-BALANCED DESIGN

ASTM-COMPLIANT

Stress paths follow ASTM-recognized triaxial-test protocols, ensuring traceable, comparable results.

ACCURATE STRENGTH

Strength measurements are free of confining-pressure bias, giving true peak and residual values.

CLEAN RESPONSE

Residual-stress response is uncontaminated by parasitic loading — essential for fracture-mechanics studies.

Hydraulic Fracturing & Acoustic Emission

High-frequency monitoring of fracture initiation and propagation

FRACLAB couples a high-pressure hydraulic-fracture injection circuit with a high-sensitivity AE module to detect and locate microcracking and fracture events during triaxial testing. Real-time, high-frequency data acquisition delivers a complete picture of damage evolution — from the first microcrack to full breakdown.

HYDRAULIC FRACTURING SYSTEM



Specimen with axial borehole

PURPOSE

Hydraulic-fracturing and wellbore-stability tests under triaxial stress; measures breakdown pressure and fracture-initiation behaviour.

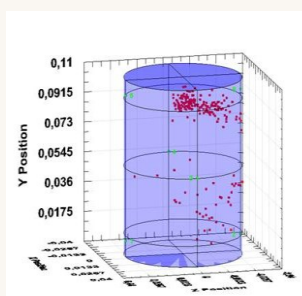
PRINCIPLE

Fluid pressure rises inside the borehole until tensile strength is exceeded — peak pressure equals breakdown pressure. After propagation, pressure decays toward pore pressure.

INJECTION CONFIGURATION

- Integrated injection platen connected to a pre-drilled axial borehole
- Dedicated fracturing-fluid pump (70 MPa, servo-controlled)
- Fluid delivered at constant rate until tensile fracture initiates
- Compatible with the Acoustic Emission (AE) monitoring system

AE MONITORING SYSTEM



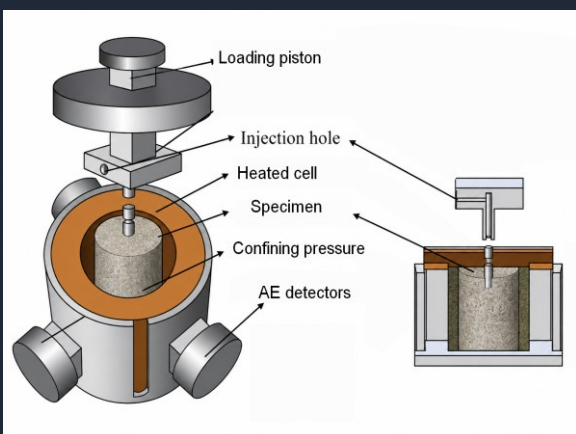
Real-time 3D event localization

KEY SPECIFICATIONS

- Sensors **6 lateral, full radial**
- Sensitivity **62 dB ref V/(m/s)**
- Frequency **125 – 750 kHz**
- Resonant **140 kHz**
- Acquisition **16-bit, 10 MHz, 8 ch**
- Location **≈ 2 mm accuracy**

CAPABILITIES

- Signal amplification: 40 dB (32 – 1000 kHz filters)
- Operating temperature range: -65 to 177 °C
- Real-time fracture-morphology reconstruction
- 2D & 3D event-localization software included



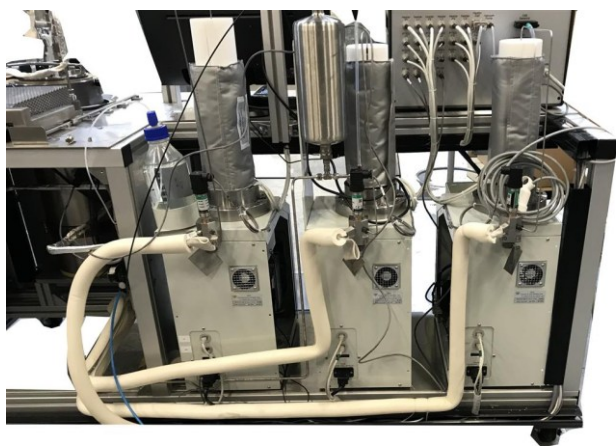
AE TRANSDUCERS — FULL RADIAL COVERAGE

Six AE detectors are mounted laterally around the heated cell, providing full radial coverage of the specimen. The pressure-balanced cell design and an injection channel through the loading piston allow simultaneous fluid injection and microseismic monitoring during the fracture experiment — an essential combination for characterizing crack initiation, propagation paths and post-breakdown behaviour.

Four High-Pressure Syringe Pumps

BT-series, servo-controlled, 70 MPa rated

Four servo-controlled syringe pumps regulate confining, axial, pore and fracturing-fluid pressures with high accuracy in closed-loop control. Each pump is independently programmable and shares a common Ethernet-based data-logging architecture, enabling synchronized control of all four fluid lines from the supervision station.



BT-series syringe pumps installed on the FRACLAB platform

COMMON FEATURES

- ◆ Working pressure: 70 MPa (10,000 psi)
- ◆ Volume: 250 cc per pump
- ◆ Flow rate: 0.0001 to 60 cc/min
- ◆ Stainless-steel wetted parts
- ◆ Integrated touch-screen panel
- ◆ Ethernet data logging
- ◆ Ambient & high-temperature operation
- ◆ Closed-loop servo control

AXIAL PRESSURE PUMP

Constant-force mode

Controls the axial load applied on the specimen via the in-vessel piston, enabling load-controlled or strain-controlled compression tests.

CONFINING PRESSURE PUMP

Constant-pressure mode

Applies confining pressure on the jacketed specimen up to 70 MPa, with closed-loop regulation independent from axial loading.

PORE PRESSURE PUMP

Drained / undrained tests

Regulates pore pressure and pore-fluid flow rate, supporting drained, undrained and constant-flow Darcy permeability protocols.

FRACTURING FLUID PUMP

Constant-flow injection

Injects fracturing fluid at a precise constant flow rate into the specimen borehole until tensile breakdown — the heart of the hydro-frac test.

Supervision, Control & Reporting Station

A unified workstation for the complete FRACLAB experiment

The FRACLAB control station integrates pump regulation, heating control, instrumentation acquisition and report generation into a single touch-friendly software environment. Operators monitor every parameter on a synoptic display, trigger automated test sequences and obtain a standardized report at the end of each experiment.



Dual-screen control station — synoptic + acquisition

CONTROL

- Synoptic display with live component status
- Independent pump control & sequencing
- Heating control (ambient to 150 °C)
- Programmable test sequences & safety interlocks

REAL-TIME ACQUISITION

- Radial & axial strains (LVDTs, extensometer)
- Axial stress & confining pressure
- Pore / back pressure & differential pressure
- Pore flow rate, temperature, AE signals

PROCESSING & REPORTING

- Automatic property calculation (E, ν , UCS, strength)
- Standardized PDF report generation
- Full data archiving with metadata
- CSV / TDMS export for further analysis

AUTOMATED EXPERIMENT WORKFLOW

1

MOUNT

Specimen jacketed and instrumented

2

CONDITION

Pore pressure & temperature stabilized

3

LOAD

Confining + axial stress applied

4

FRACTURE / TEST

Injection or compression sequence

5

REPORT

Auto data processing & PDF report

Typical Applications

Where FRACLAB delivers value

FRACLAB is the ideal platform for advanced rock-mechanics research in academic, energy and geotechnical sectors. Its combination of triaxial loading, hydraulic-fracture injection and acoustic-emission monitoring makes it equally well suited to fundamental research and applied engineering studies.

Oil & Gas

UNCONVENTIONAL RESERVOIRS

Characterization of shale, tight sandstone and carbonate formations: breakdown pressure, fracture propagation and proppant effectiveness.

CO₂ / H₂

GEOLOGICAL STORAGE

CO₂ and hydrogen underground storage studies: caprock integrity, fracturing under reactive fluids, long-term containment assessment.

EGS

GEOHERMAL ENERGY

Enhanced Geothermal Systems: fracture-network generation, thermo-hydro-mechanical coupling, reservoir-stimulation studies.

Fundamental

ROCK MECHANICS RESEARCH

Studies of damage evolution, fracture toughness, acoustic-emission signatures and failure mechanisms in intact and fractured rock.

Infrastructure

CIVIL & MINING ENGINEERING

Rock-strength characterization for tunnelling, dam foundations, deep excavations and rock-slope stability analyses.

Long-term storage

NUCLEAR WASTE DISPOSAL

Evaluation of host-rock fracture behaviour, sealing capacity and long-term integrity for deep geological repositories.

FROM LABORATORY RESEARCH TO INDUSTRIAL DEPLOYMENT

Whether you are a university group studying fracture initiation, an energy operator screening reservoir candidates, or an engineering firm validating rock-strength assumptions for a major project, FRACLAB delivers laboratory-grade data with the speed and traceability required for modern geomechanical decision-making.



Hydraulic Fracture Test System

FRACLAB

CONTACT US

We're happy to discuss your application and customize the FRACLAB platform to your needs.

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