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Research Unit Mining

Fracture behaviour of slate

Combined analysis of experiments and simulations

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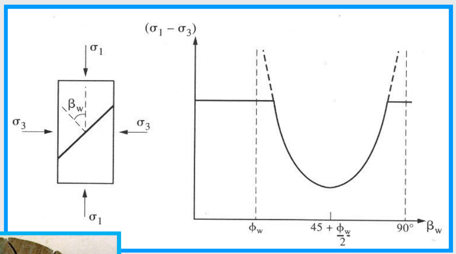
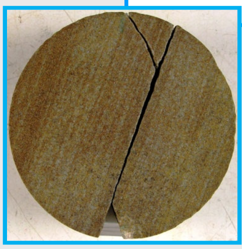
The global research of the past years focused on

- Rock with planar heterogeneities (e.g. pre-existing fractures, veins)
- Layered rock : e.g. **slate** ('schistosity'), siltstone and layered sandstone

Transversally isotropic behaviour





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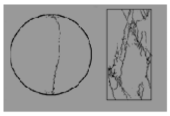
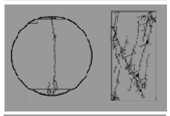
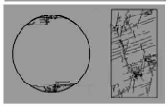
The main question :

Is the behaviour of such rock as simple as usually assumed?

The answer is no.

The degree of μ-scale anisotropy determines the sample strength, fracture pattern and fracturing mechanisms.

Framework relating μ-scale anisotropy to

	Strength (sample scale) & fracture pattern	Fracture pattern	Examples
Small or no strength anisotropy	=f(layer) =f(non-layer) ≠f(θ)		layered sandstone (Tavallali)
Medium strength anisotropy	=f(layer) =f(non-layer) =f(θ)		siltstone (Debecker)
Large strength anisotropy	=f(layer) ≠f(non-layer) =f(θ)		**slate** (Debecker)

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Aim of the study

To map, identify and analyse individual fracture growth in slate by a combined approach of experiments and numerical simulations

1. To contribute to the development of
   - numerical modelling of individual fracture growth (DEM)
   - experimental techniques (Image analysis & AE-localisation)
2. To construct a framework that relates μ-strength anisotropy to
   - macro-strength anisotropy
   - fracture behaviour (patterns and mechanisms)
   - deformation behaviour

Diametrical load tests

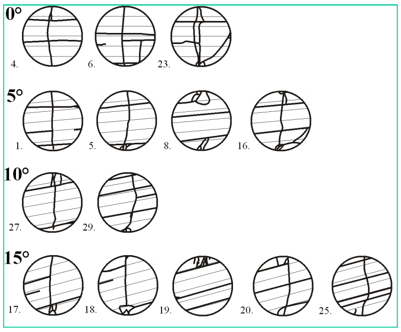
Uniaxial load tests (θ =20º)

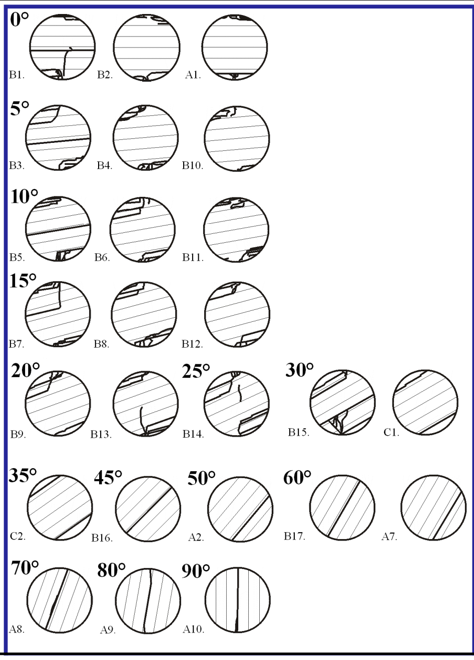
Diametrical Load Tests

experiments

Large strength anisotropy (slate)

Medium strength anisotropy (siltstone)





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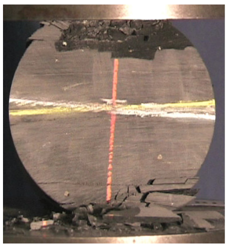
Diametrical Load Tests

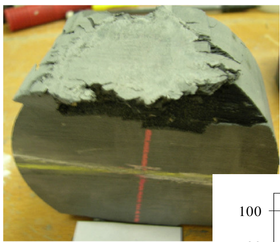
experiments

Large strength anisotropy (slate)

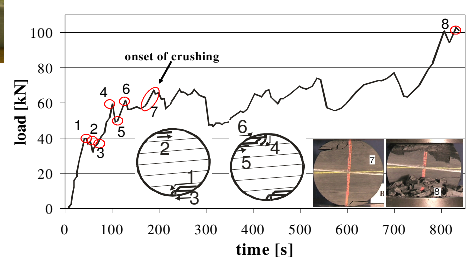
θ : 5°

Intensive μ-fracturing results in **crushing** of slate samples





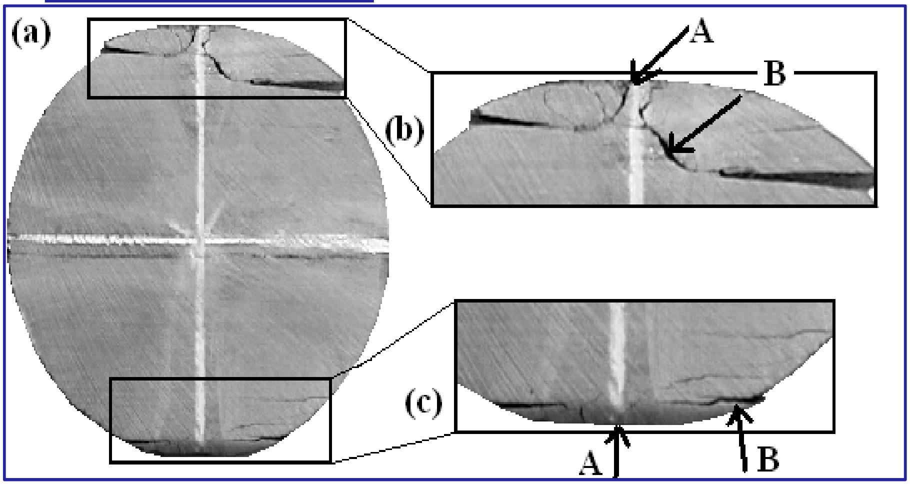
→contact surface increases, load does not decrease



Diametrical Load Tests *experiments*

Large strength anisotropy (slate)

θ : 0°



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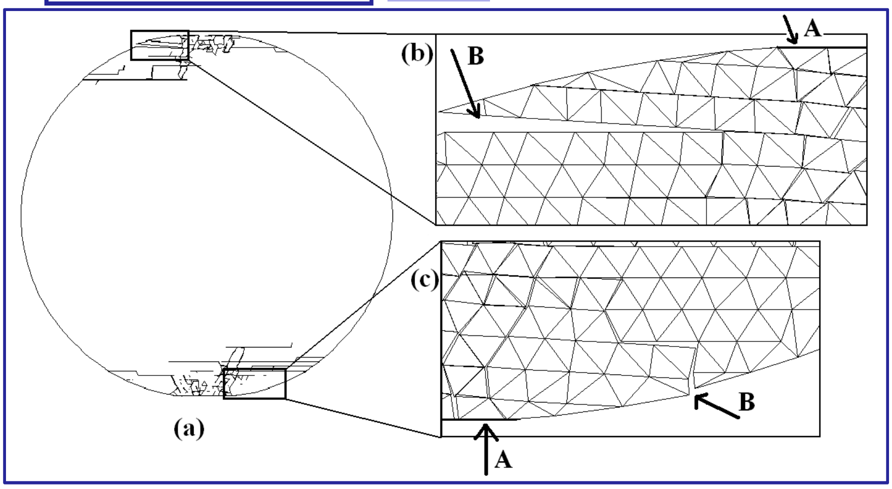
Diametrical Load Tests *simulations*

Large strength anisotropy (slate)

θ : 0°



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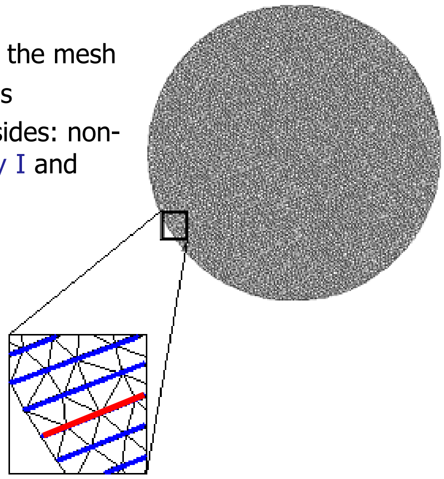
Numerical Simulations

Distinct element code UDEC

- Sides of triangular blocks form the mesh
- Mesh = potential fracture paths
- Three different properties for sides: non-schistosity direction, schistosity I and schistosity II



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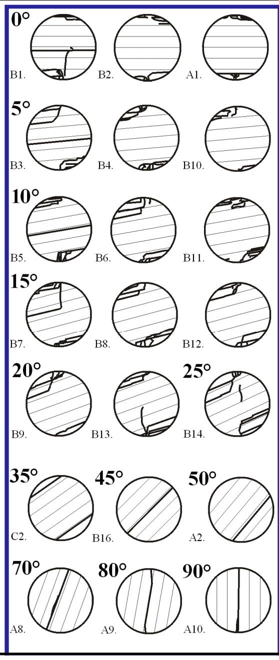
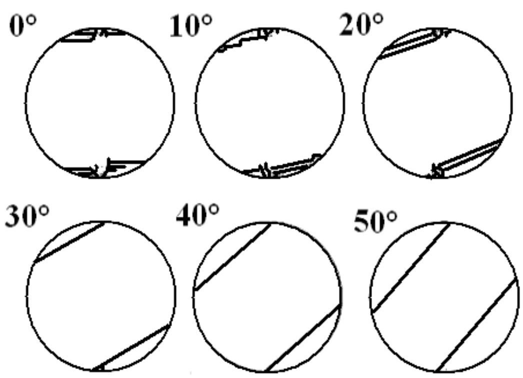
Diametrical Load Tests

Large strength anisotropy (slate)

experiments



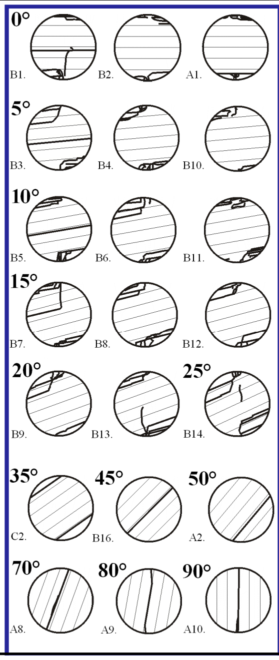
simulations



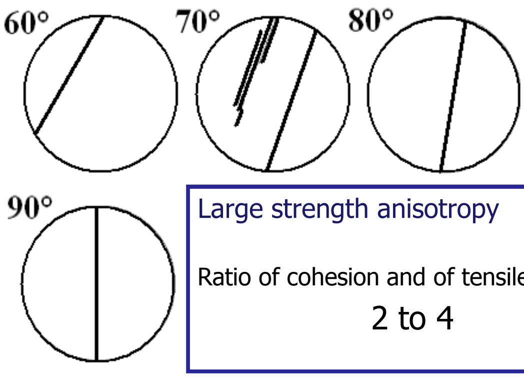
Diametrical Load Tests

Large strength anisotropy (slate)

experiments



simulations



Large strength anisotropy

Ratio of cohesion and of tensile strength

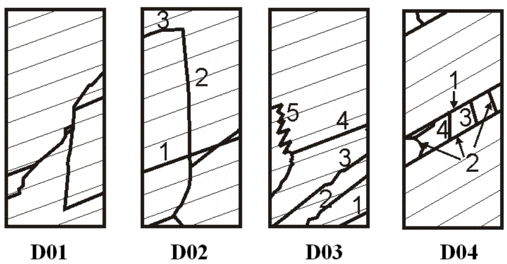
2 to 4

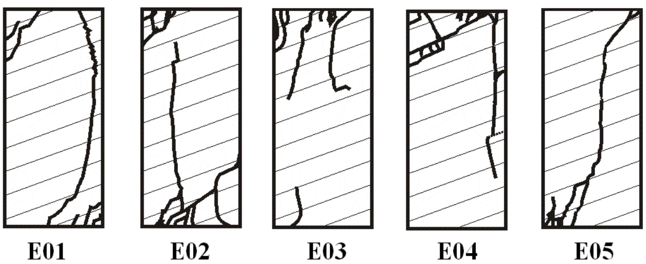
Uniaxial Load Tests

Large strength anisotropy (slate)

experiments

θ : 20° or 30 °





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Uniaxial Load Tests

Large strength anisotropy (slate)

experiments

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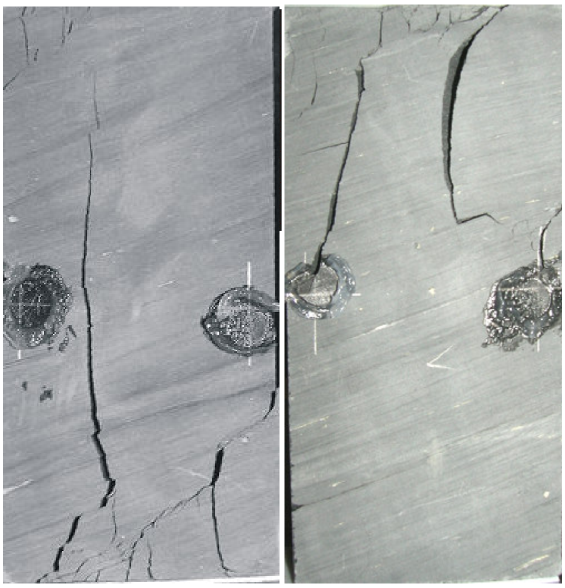

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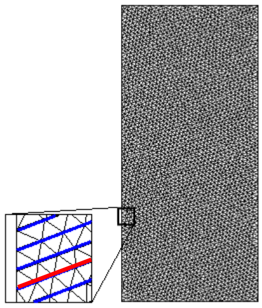
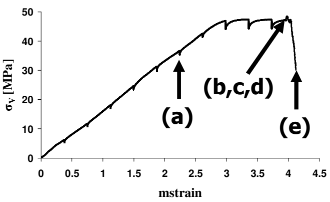
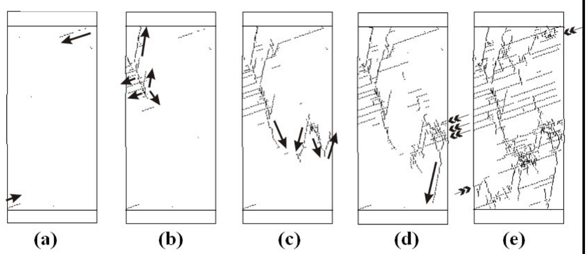
Uniaxial Load Tests

Large strength anisotropy (slate)

simulations







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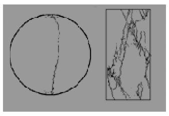
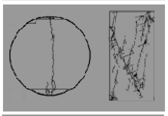
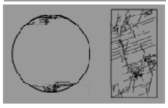
Conclusion: importance of µ-scale anisotropy

	Strength (sample scale) & fracture pattern	Fracture pattern	Examples
Small or no strength anisotropy	=f(layer) =f(non-layer) ≠f(θ)		layered sandstone (Tavallali)
Medium strength anisotropy	=f(layer) =f(non-layer) =f(θ)		siltstone (Debecker)
Large strength anisotropy	=f(layer) ≠f(non-layer) =f(θ)		slate (Debecker)

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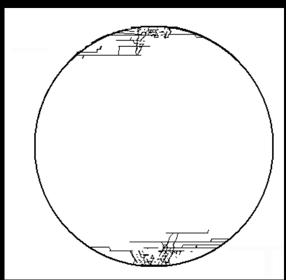

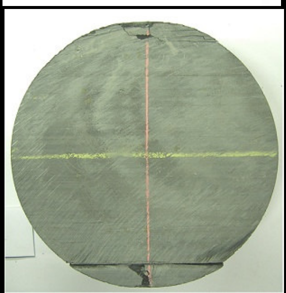

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