The SELFRAC project

F. Bernier

SELFRAC Exchange Meeting

Monday 4 October 2004

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Why the SELFRAC project?

- What is EDZ-EdZ?
  - At the time, no clear terminology
  - Definitons related to mathematical model
- How is EDZ created?
- How does EDZ evolve?
  - Sealing/Healing
- How is EDZ handled in PA?
  - What is the impact of EDZ on performance?
- How can we control it?

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Two clays has been studied

- The Opalinus Clay
  - Indurated clay
  - Mt. Terri underground laboratory
- The Boom Clay
  - "Plastic" clay
  - HADES underground laboratory
- Fracturing scheme around excavations has been well characterised

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Understanding and quantification of

A Increase of permeability related to crack proliferation around excavation in clays

B Decrease of permeability by sealing/healing process

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The SELFRAC consortium

- Co-ordinator

  EIG EURIDICE (SCK•CEN - NIRAS/ONDRAF)

- Partners

  NAGRA, SOLEXPERT, LMS(G3S), L3S,KUL,EPFL

- Budget: 2000 K€

  (EC Contribution: 900 K€)

- Duration: 36 months (Start in December 2001)

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The measurable objectives are

- Review and reporting of the state of the art
- Terminology: EDZ/EdZ, sealing/healing
- Experimental characterisation of processes A and B
  - More than 90 laboratory tests
- Improvements and development of constitutive models to simulate processes A and B
- Four in-situ tests
- Comparison of numerical simulations and experimental results
- Conclusions and recommendations about the long-term performance of a nuclear repository

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Synthesis of the EDZ cluster conference

Chin-Fu Tsang

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The scope of the workshop covers:

- Crystaline rock, salt, clays (indurated/plastic)
- The present understanding of the nature and properties of EDZ
  - impact of construction techniques
  - importance of repository conditions
  - evolution of the EDZ
- Practical consequences for different repository stages
  - design, construction, operation, closure
- Impact on safety

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EDZ versus EdZ

- The Excavation Disturbed Zone (EdZ) is a zone with hydromechanical and geochemical modifications, without major changes in flow and transport properties. Within the EdZ there are no negative effects on the long-term safety
- The Excavation Damaged Zone (EDZ) is a zone with hydromechanical and geochemical modifications inducing significant changes in flow and transport properties. These changes can, for example, include one or more orders of magnitude increase in flow permeability.

Sealing/Healing

- Sealing is a reduction of fracture permeability by any hydromechanical, hydrochemical, or hydrobiochemical processes.
- Healing is sealing with loss of memory of the pre-healing state.

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Many similarities in the EDZ processes within the rock types

- Observation
- Concepts
- Testing methodologies
- Numerical models

  are often transferable

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The EDZ behaviour is a dynamic problem dependent on changing conditions which varies from open-drift period to closure period

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The excavation stage

- The stress redistribution is the key cause of the EDZ
  - giving rise to tension, compression and shear
- EDZ processes are intrinsically anisotropic
  - anisotropic properties of the rock
- Influence of the excavation method
- A back-pressure from a rock support system can help to limit the EDZ

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Open-Drift stage

- Ventilation dehydrates the rock near the drift surfaces
  - strengthening of the rock
  - changing creep properties =>retarding self-sealing
- Air entering the rock
  - oxidation
  - two phase flow
- EDZ cut-off to prevent high-permeability continuous flow path

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Closure stage

- The system becomes fully saturated
- Heating phase followed by cooling phase
- Sealing by
  - dilantancy
  - creep
  - swelling
  - consolidation
  - newly formed minerals

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- The assumption that the presence of an EDZ provides a fast pathway for the escape of radionuclides to the biosphere is now recognised as an oversimplification!
- Transport solute require the evaluation of the total flow system
- If the high-permeability zone is surrounded by low-permeability regions, or the hydraulic gradient is sufficiently low, there will be an insufficient supply of flowing water in the EDZ to impact the repository performance

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- A full scientific evaluation of all conditions is not necessary for PA of a repository
  - a high level of understading is required
    - to provide confidence building
- Good performance assessment can be made through conservative bounding, scoping, and sensivity studies

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Bottleneck issues

- Need to study anisotropic behaviour in deformation and flow within the EDZ
- Need to study seal-rock interface and effectiveness of drift seal and EDZ cuttoffs
- Need to conduct comprehensive performance assessment studies of EDZ

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