

# Rock Engineering and Environmental Issues

## General Report

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# Environmental Issues

**Subject that can include virtually everything**

**This reflects on the issues in this theme:**

**Virtually all aspects of rock engineering have something to do with the environment**



# Articles submitted in this theme range from:

**Fundamental research in behavior and grow of  
discontinuities (cracks, joints, etc.)**

**to**

**Case histories on behavior of underground  
openings and pipe-jacking**



# Rock mechanical issues addressed in the articles:

- **Discontinuity grow under stress**
- **Temperature influence**
- **Radioactive radiation**
- **Flow of fluids and gasses**
- **Acid leaching**
- **Uncertainty of Geodata**
- **Long-time behavior of rock masses**



# Methodologies used in the articles:

- Numerical calculations
- Classification
- Descriptive
- Testing (large and small scale – field and laboratory)



# New trends:

- **Difficult to identify**

rather more

- **New aspects of existing methodologies**



# Grouped the articles into main subjects:

- Discontinuity initiation, strength, and hydro-mechanical characterization
- Rock mechanics and influence of nuclear radiation and temperature
- Temperature and weathering and erosion
- Influence of changing groundwater levels on mining or abandoned mines
- Underground excavation and construction
- Acid water and ground
- Uncertainty of Geodata



# Purpose:

- (Nuclear) waste disposal sites (boasted by the climate discussion)
- Mine closure (remedial works and consequences)
- Rising groundwater levels and influence on surface settlement and structures
- Weathering and erosion of historical sites
- Stability residential areas
- Underground infrastructure





# Crack initiation and hydro-mechanical characterization (1)

- Crack initiation and grow very popular some 30 years ago (continuum rock mechanics)

later interest shifted more to existing discontinuities (discontinuous rock mechanics)

- Receives now new interest in relation to hydro-mechanical characterization for forecasting of permeability for long-time waste disposal sites



# Discontinuity initiation, strength, and hydro-mechanical characterization (2)

- Crack initiation and growth (Nara & Kaneko and Obara et al.)
- Over-closure of discontinuities (and hence a strength more than expected, if, for example, discontinuity has been heated before) (Barton)
- The hydraulic characteristics under influence of water and water vapour by Obara et al.
- Microdeformation (Valès et al.)
- Hydraulic characteristics of new and existing discontinuities (Koyama & Jing, Kihm et al., Valès et al., and Sato & Sawada)



# Rock mechanics and influence of radiation and temperature

- Influence of radiation and temperature on rocks (Johansson et al. and Mizuta et al.)
- Volume of micro-cracks important for retention of nuclear waste and radioactive material and fluids (Jacobsson et al.)
- Influence of the excavation damage on the hydro-mechanical characteristics of the surrounding rock mass (Armand et al.)



# Temperature, weathering and erosion (1)

- Influence of temperature on the deformation characteristics of rock slopes (Dünner et al.)
- Wind erosion effects on historical sites (Haiying et al.)
- Stability of natural historic caverns (Zhong et al.)
- Influence of weathering (solution) of limestones in a residential area (Han et al.)
- Erosion of rock masses along a spillway (Mörén & Sjöberg)



# Changing groundwater levels on mining or abandoned mines

- Surface effects caused by changing groundwater levels on mining or abandoned mines (Grgic et al., Garzonio, and Yu et al.)

# Underground excavation and construction (1)

- Excavation damage (Armand et al.)
- Spalling potential and brittle zone identification for a nuclear waste disposal site (Johansson et al.)
- Sewage system - pipe-jacking (Heinemann& Tegelkamp)
- Sewage system - pipe-jacking in gypsum (Erichsen et al.)



# Underground excavation and construction (2)

- Underground constructions for infrastructure in Guangzhou, China, (Jinchao)
- Subsidence and safe overburden cover thickness for mining (Taylor & Fowell and Sunwoo & Ryu)

# Acid water and ground

- Influence of artificial or natural acids in the groundwater and the influence on the rock mass (Ormaetxea and Igarashi et al.).



# Uncertainty of geodata

- Uncertainty in (engineering) geological interpretations (Tegtmeier et al.) (of which this speaker is co-author)

# Research versus application

- Discontinuity initiation and growth is of a theoretical nature.
- The research for the long-term storage of nuclear waste, and the influence of temperature and radiation are pure research but are also of clear public interest.
- Other articles have a more direct public interest.



# Three versus two dimensional modelling

- Three-dimensional numerical modelling seems to become more applied in research,
- but, in particular, also more in the case histories.

New compared to congresses of only a couple of years ago when two-dimensional analyses were still in the majority.



# Countries of origin

- In total 27 articles
- From a wide range of countries
- Most articles from Western Europe
- No articles come from the Americas, Australia, and Africa.
- Relative large quantities of articles are submitted from China, Japan, and Korea.
- Remarkable absent countries are, for example, Austria, Switzerland, and Greece
- Complete absence of articles from Eastern Europe



# Countries of origin

country	number of articles	country	number of articles
Europe	16	Other continents	11
Finland	1	China	3
France	4	Japan	5
Germany	2	Korea	3
Italy	1		
Netherlands	1		
Norway	1		
Spain	1		
Sweden	3		
UK	2		

based on country of origin of first author



# Cooperation over national and international boundaries

- In the past, in particular, in rock engineering intensive international cooperation existed
- Now, the international cooperation seems to have been virtually completely evaporated
- Only one article has been submitted that is written by authors working in different countries (Johansson et al.)
- 10 articles out of a total of 27 articles originate from one organization only



# Concluding remarks

The articles submitted to theme 1 “Rock Engineering and Environmental Issues” are:

- For a large part directly or indirectly related to the storage of nuclear waste.
- Three-in instead of two-dimensional modelling
- Little or no attention for reliability and certainty of geodata
- The number of countries from which articles originate is fairly limited with some remarkable omissions
- International and national cooperation seems to be reduced.

