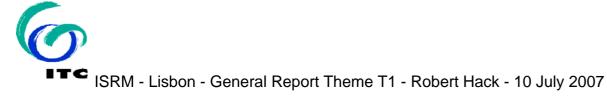
# **Rock Engineering and Environmental Issues**

#### General Report International Society for Rock Mechanics – ISRM 11<sup>th</sup> Congress – Lisbon - July 2007

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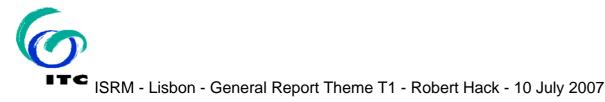


#### **Environmental Issues**

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

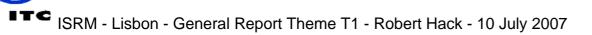


ISRM - Lisbon - General Report Theme T1 - Robert Hack - 10 July 2007

# 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 hydromechanical 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 hydromechanical characterization for forecasting of permeability for long-time waste disposal sites



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

- •Crack initiation and grow (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.)

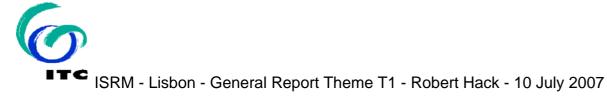
 Influence of the excavation damage on the hydromechanical characteristics of the surrounding rock mass (Armand et al.)



#### 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)

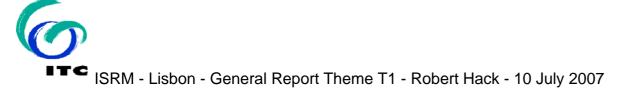
•Subsidence and safe overburden cover thickness for mining (Taylor & Fowell and Sunwoo & Ryu)



### Acid water and ground

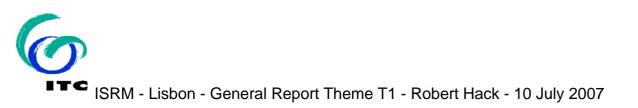
•Influence of artificial or natural acids in the groundwater and the influence on the rock mass (Ormaetxea and Igarashi et al.).





# **Uncertainty of geodata**

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





### **Research versus application**

•Discontinuity initiation and grow 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.

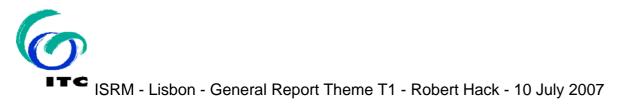




#### Three versus two dimensional modelling

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.

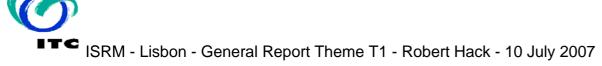




# **Countries of origin**

- 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 stead 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.

