

WORKSHOP ON MINERAL RESOURCES RESEARCH
10 – 12 June 2015

**The Academy of Finland (AF) and the South African National Research
Foundation (NRF)**

Mining education and research at Aalto University

- Mining and Rock Engineering in Finland
- Aalto University
- Education of Mining / Rock Engineers
- EMMEP master program
- On-going research

Prof. Mikael Rinne

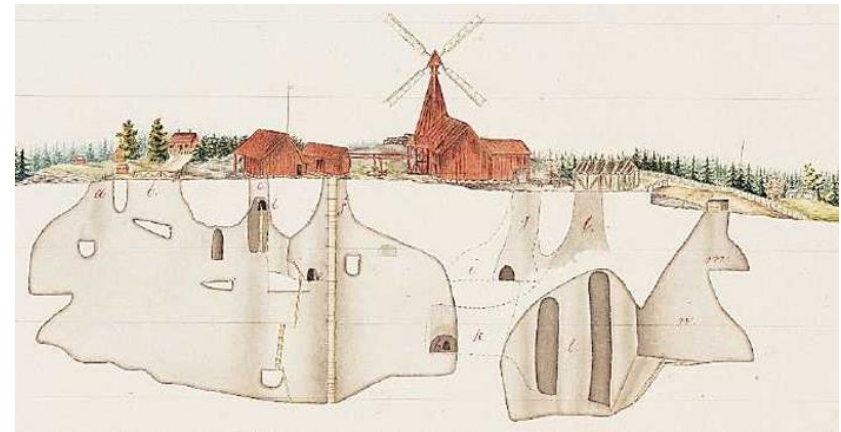
June 2015

History of mining in Finland

- The first written documents related to mining in Finland date to the 13th century (Three farmers in SW Finland donate Krakanäs limestone deposit to save their souls)
- Extraction of metals: King Gustav Vasa gave Erik Fleming (1542) rights for Ojamo iron mine at Lohja (Nyby ironwork started at Ojamo ore in 1530)
- Outokumpu ore (Cu, Co) was discovered in 1910
- More than a thousand mines have been in operation.
- In operation : ~ 50 mines with of ~ 10 metal mines, ~ 40 industrial minerals incl. limestone

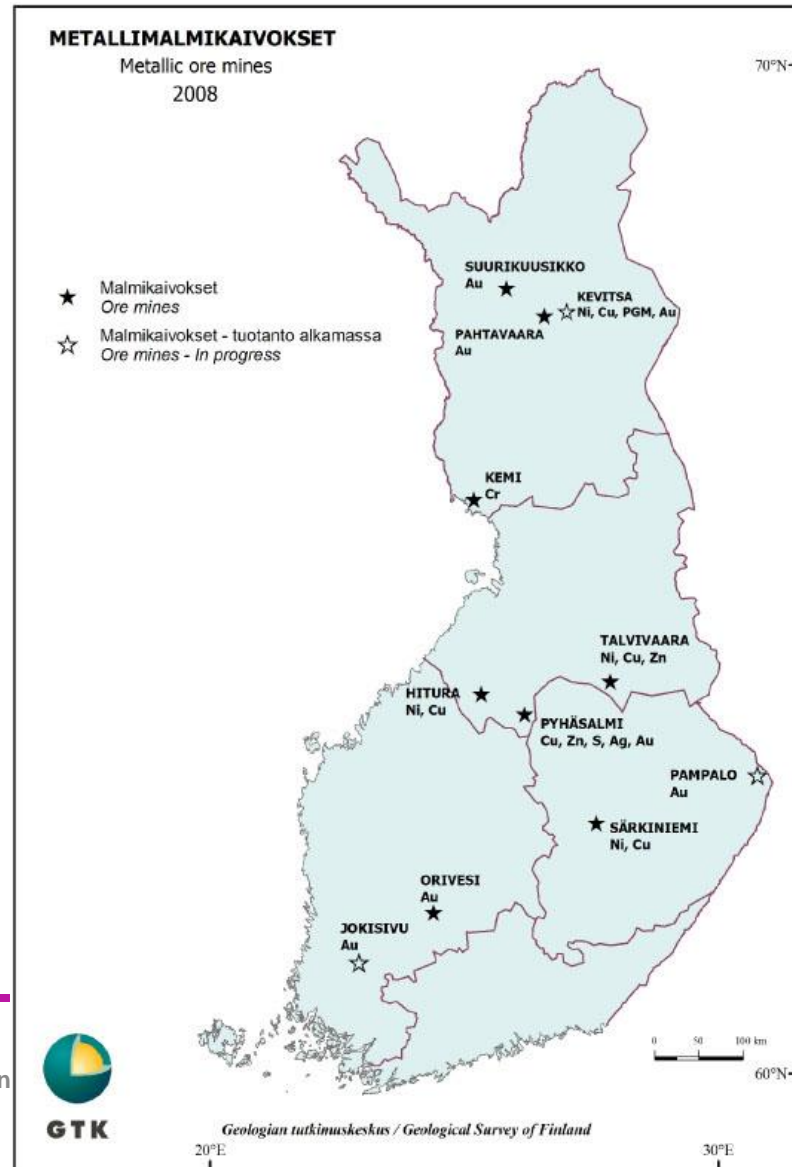
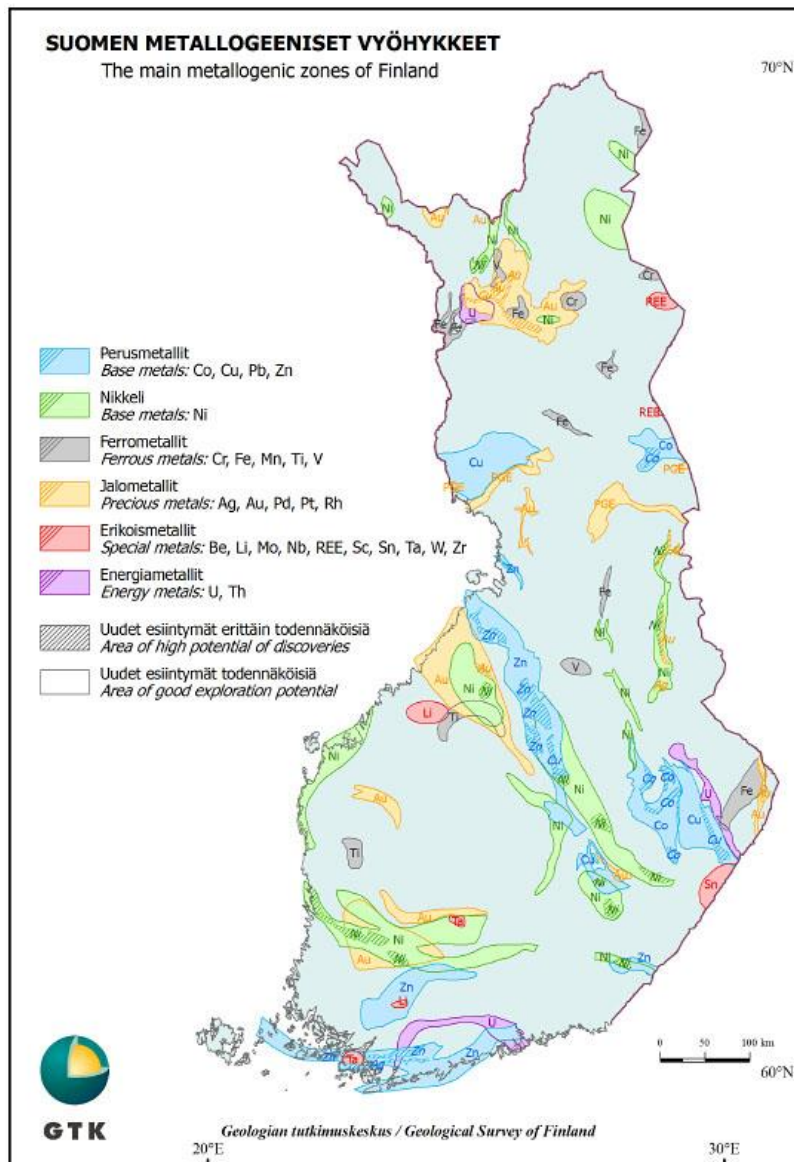


Nordkalk



Vihti Orijärvi Mine (1757-1956)

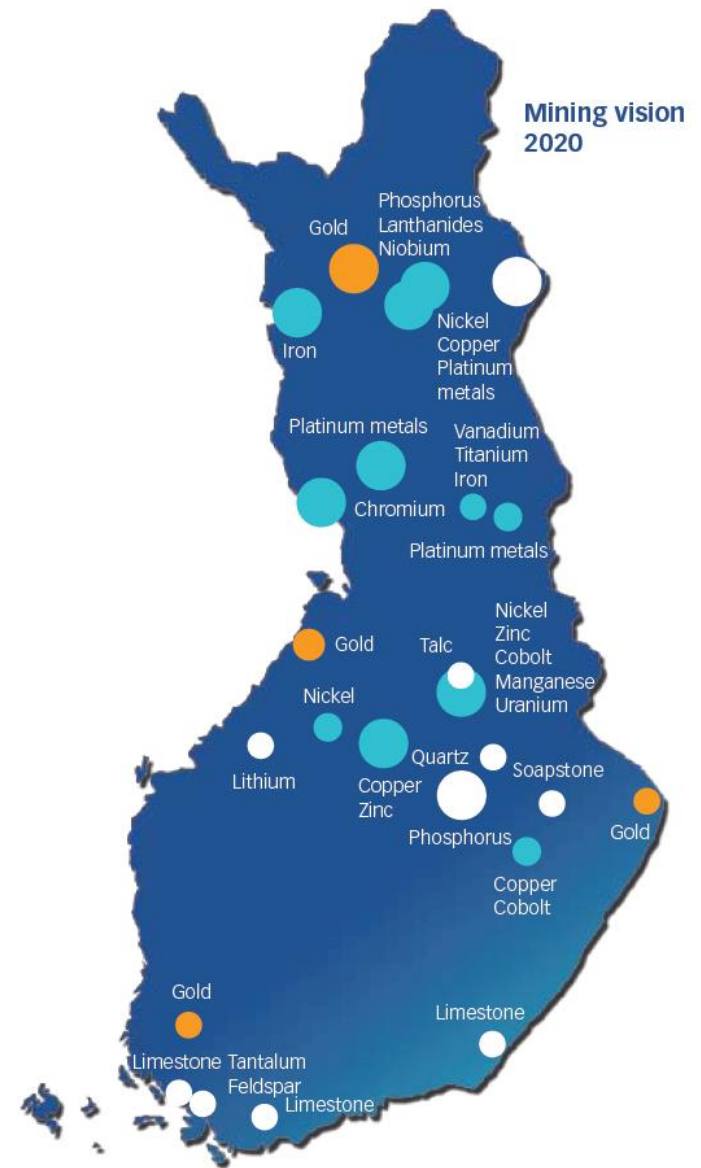
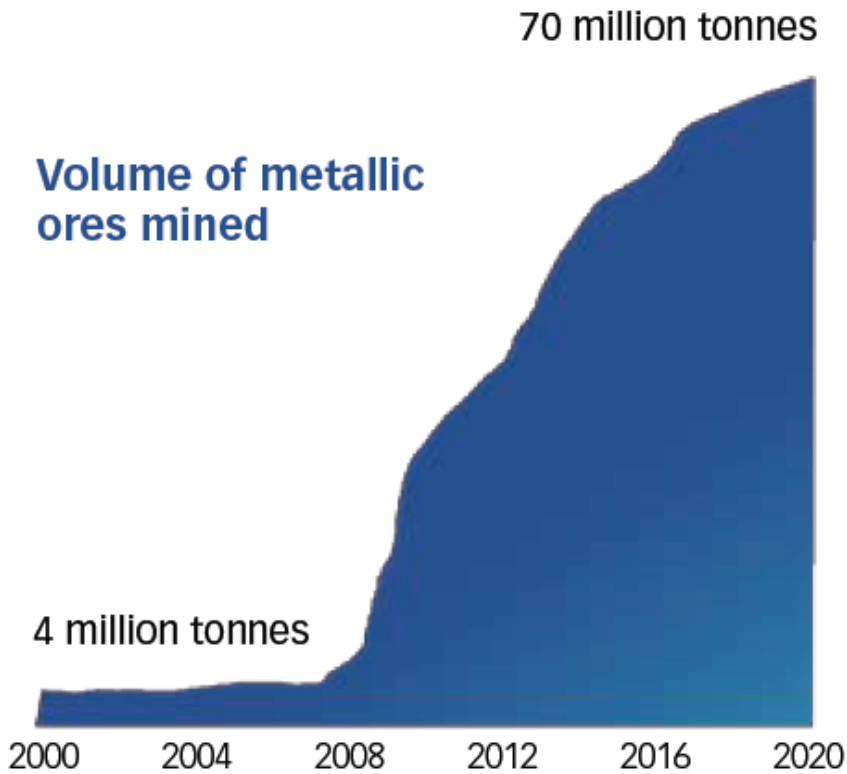
Metallogenic zones and mines



Great expectations

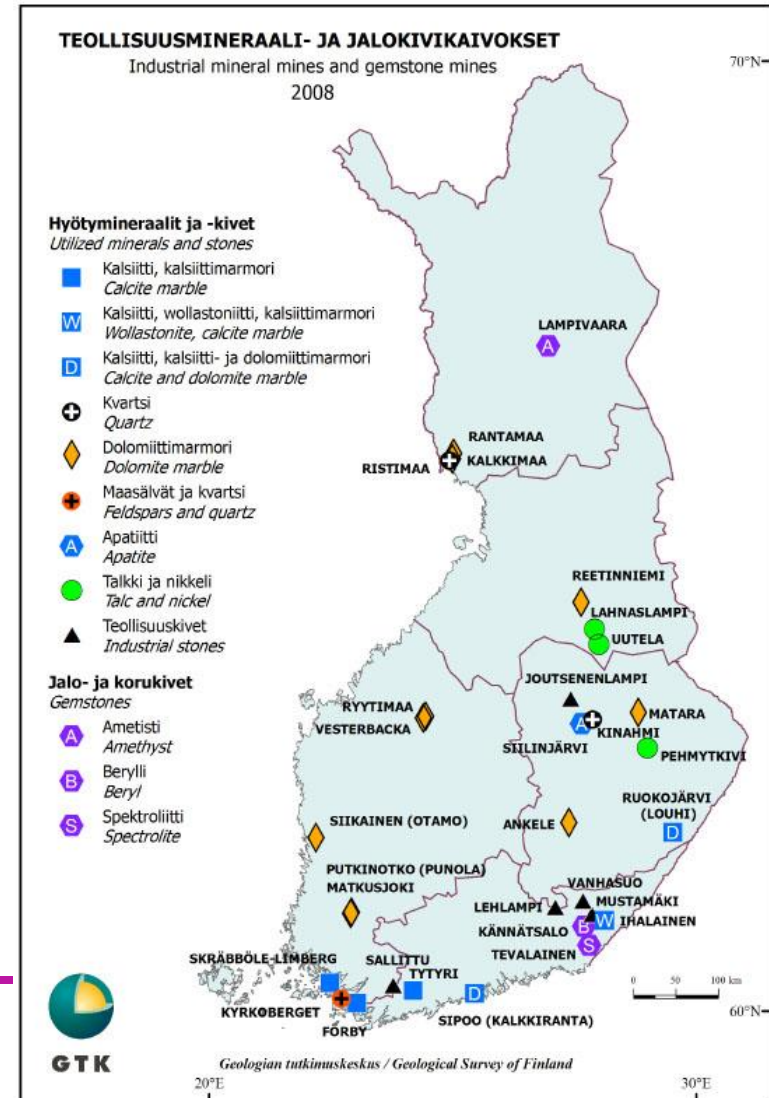
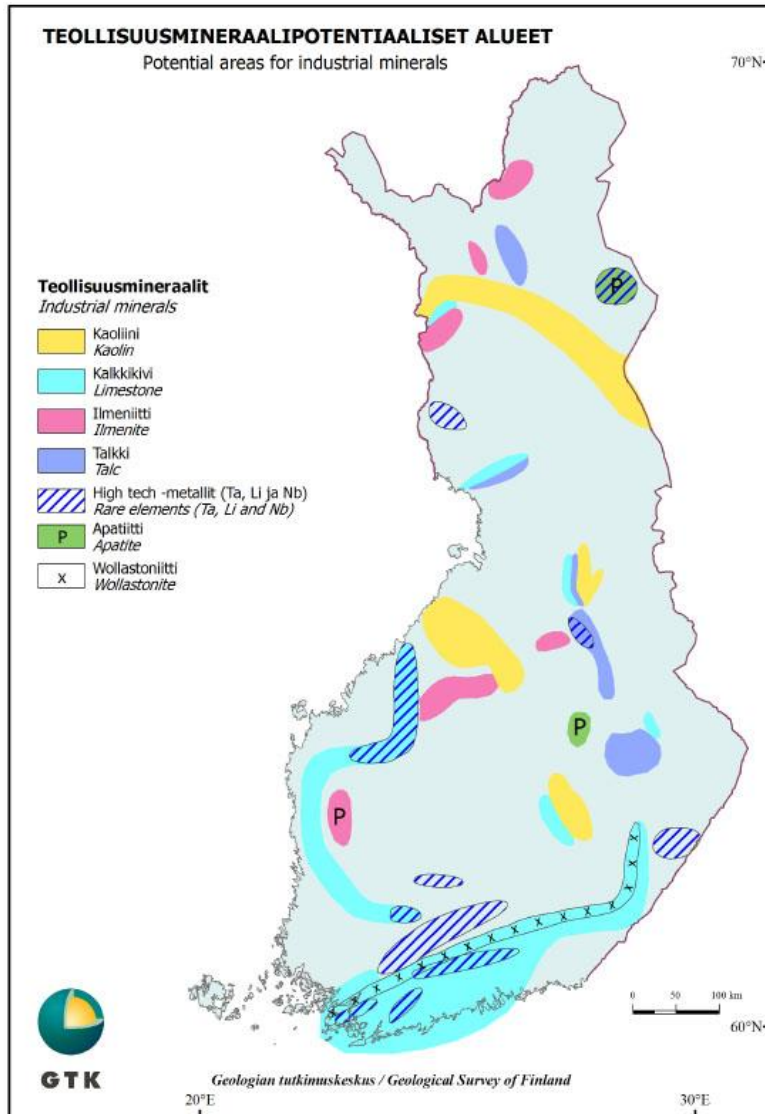
Finland's Minerals Strategy

Can be downloaded from internet



Industrial minerals and mines

2008: 33 quarries,
20,4 Mt/a



10, 2015

Rock Engineering in Finland

- Traffic tunnels and UG parking areas
- Civil shelters
- Multiple purpose tunnels (freshwater, sewage, cables...)
- Technical (eg. server) rooms and storages
- Water treatment plants, water distribution
- Power stations and heat distribution
- Facilities for sports and gyms, ski-tunnels (!)..
- Restaurants, church, art hall...

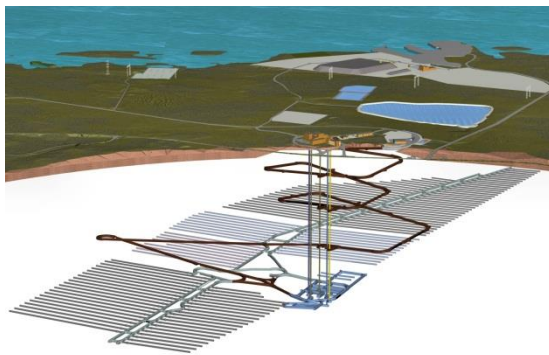


Ongoing projects and plans ...

🎯 Aalto University



Länsimetro, Underground line West from Helsinki (ready 2016)



Posiva, Final disposal of radioactive waste (construction planned to start 2015)



Ring rail line between Helsinki City and the airport (ready 2014)



Center line in Helsinki City (under planning)

Aalto University - Where *Science* and *Art* meet *Technology* and *Business*

Aalto University, Espoo campus.



A merger of leading Finnish universities in 2010

University of Art and Design Helsinki (TaiK)
Helsinki School of Economics (HSE)
Helsinki University of Technology (TKK)

A community of:

- 75,000 alumni
- 20,000 students
- 4,700 faculty & staff
- with 340 professors



Art, Business, Science and Technology

Mining

Beneficiation, metallurgy

School of...

Economics

**Art and
Design**

Engineering

**Chemical
Technology**

Science

**Electrical
Engineering**

Research Team Geoengineering 2015

prof. Mikael Rinne,
Rock Mechanics (Mining and
rock engineering)
Team leader



prof. Jussi Leveinen,
Engineering Geology



prof. Leena Korkiala-Tanttu,
Geotechnical Engineering



prof. Terhi Pellinen,
Highway Engineering



Research focus: Arctic
geoengineering and
mineral resources.

prof. Wojciech
Sołowski,
Geotechnical
Engineering



**Staff Σ ~ 35-40
persons**

Mining Master's thesis topics 2013-2015

- New tools to optimize mine ventilation and equipment scheduling
- Mining method evaluation and dilution control in Kittilä mine
- Technical and economic evaluation for the in pit crushing and conveying (IPCC) system implementation at the Siilinjärvi mine
- Modeling slope stability utilising fracture mechanics (Aitik)
- Geotechnical Risk Assessment guideline for underground mines-case Pyhäsalmi
- Porphyry ore body zonality for the mine planning in context of processing performance – Mikheevskoye mine
- The effect of electronic detonators on stoping at Pyhäsalmi mine
- Monitoring and evaluation of sublevel caving at Hitura mine
- Ore quality and rock mass information from drill holes in UG mining
- Development of blasting design to optimize fragmentation - Talvivaara mine
- Rock mechanical designing of shallow seated rock caverns
- The influence of electronic detonators on fragmentation and ground vibration
- Guidelines for geotechnical risk assessment in underground mines
- Risk assessment with geostatistical estimation in mine planning
- Dewatering open pit mine by exploiting underground pumping station
- Excavation quality and statistical evaluation of laser scanned tunnel cross-sections

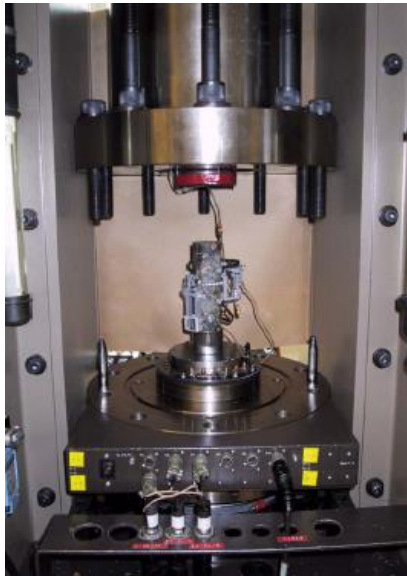
Ongoing research projects:

- **Mine-wide information and control systems (PhD thesis project)**
EU-funded I2Mine project (Innovative Technologies and Concepts for the Intelligent Deep Mine of the Future)
- **Evaluation methods of geohazards in deep mining (I2Mine project)**
- **Dust emission from open-pits (PhD thesis project)**
- **Development of on-line rock stress measurement (GreenMining, Tekes)**
- **Mechanical behaviour of Olkiluoto rocks (PhD thesis project)**
- **Interaction of sprayed concrete and hard rock (PhD thesis project)**
- **Scaling of rock fracture strength properties (KARMO)**
- **Solutions for long-term energy storage in “New Energy Solar Community Concept (SCC) project”- Finnish Academy (PhD thesis project)**

Rock laboratory

- testing and research

**Pressure apparatus
MTS 815
for material testing**

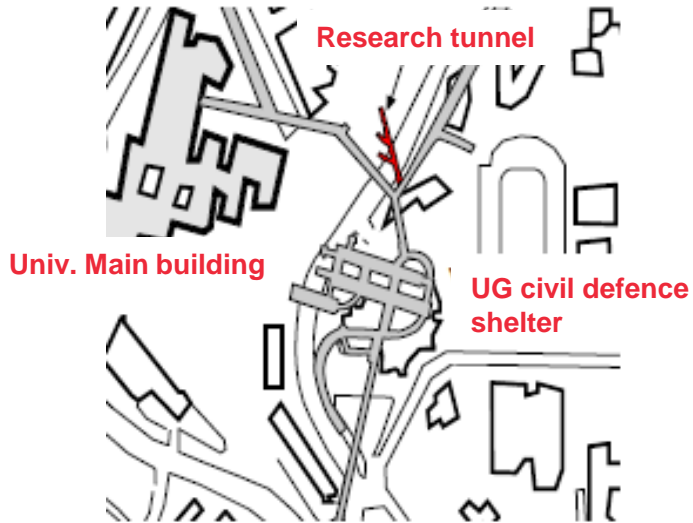


- Strength and deformation properties of rock, backfill, concrete etc.
- Drillability properties of rock
- Frictional properties of rock joints
- Point load strength of rock
- Tilt table device etc



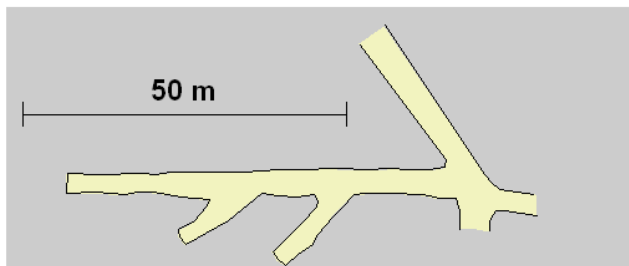
Research tunnel

campus of Otaniemi in Espoo



- **Drilling, bolting, hauling & loading exercises**
- **Research and development project**

Research tunnel



<http://www.emmep.org/>



European Mining, Minerals and Environmental Program (EMMEP)

- 2-yr master's program, 120 ECTS, started in 2014
- Based on experience from 1-yr program in 1996-2013, TU Delft (coordinator), RWTH Aachen, Miskolc, Wroclaw, Aalto
- Tracks:
 - EMC -Mining, emphasis on mining (*Aalto, Aachen, Delft*)
 - EMEC -Mineral processing, metallurgy, recycling (*Miskolc, Wroclaw, Aalto*)
 - EGEC -Mining, emphasis on geotechnical and environmental (*Miskolc, Wroclaw, Delft*)
- Industrial support via FEMP foundation
- Strong alumni cooperation

Locations for studies

	1st year, Semester 1	Semester 2	2nd Year, Semester 3	Semester 4
EMC	Aalto, Espoo	Aachen	Delft	Thesis
EMEC	Miskolc & Wroclaw	Helsinki	Helsinki	Thesis
EGEC	Miskolc (HU)	Wroclaw (PL)	Delft	Thesis

Courses



Company visits



Social activities



Student enrolment

to/incl. 2013-2014 academic year:

Total enrolment European Mineral Programs 1996-2013

Continent	EMC	EMEC	EGEC	Total
Europe	284	173	105	562
N. America	30	2		332
S. America	4	30	2	37
Australia	3			3
Africa	3	8	7	20
Asia	13	10	18	46
Total	339	214	135	700

EMMEP is funded by FEMP- Federation of European Mineral Programs



Structure FEMP

Associated universities

Canada: Queen's, McGill, UBC
USA: Colorado School of Mines, Virginia Tech
Australia: Queensland
Chile: Concepcion, Catholica
Brasil: Federal do Rio Grande
Europe: France, Norway, Sweden, Austria, Estonia etc.

European Universities

EMMEP
 - EMC
 - EMEC
 - EGEC

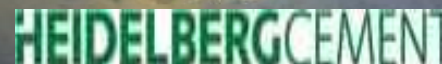
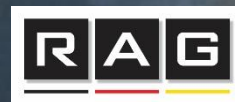
FEMP

Industry

Agnico Eagle
 Aker-Wirth
 AKZO-Nobel
 Anglo American Plc.
 Areva
 Atlas Copco
 Barrick Gold Corpor
 BHP-Billiton
 Boliden
 Caterpillar
 Euromines
 Gemcom
 IAMGold
 IHC
 Inmet
 K + S
 KGHM
 Lhoist
 Metso Minerals
 Normet
 Nyrstar
 Orica Mining Services
 Outotec
 RAG
 Resource Capital Funds
 Royalhaskoning DHV
 RWE Power
 Shell
 SRK Mining Services
 Tata
 Talvivaara
 Rio Tinto
 Sandvik
 SGS Minerals
 Vereinigung Rohstoffe und Bergbau
 Walter Beckers
 Xstrata

A!

FÈMP - industrial partners



The image shows the interior of the Temppeliaukio underground church in Helsinki. The most striking feature is the vaulted ceiling, which is a grid of white, ribbed concrete. The walls are made of natural, rough-hewn stone. On the left, there is a large wooden organ. In the center, there is an altar area with a cross and candles. To the right, there is a Christmas tree decorated with lights. The floor is light-colored, and there are several rows of wooden pews with purple cushions. The overall atmosphere is modern and minimalist.

THANK YOU!

Temppeliaukio underground church,
Helsinki City