Rock Engineering, Mining Education, and the Road Ahead

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Insinööritieteiden korkeakoulu

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Tieteiden talo, Helsinki

Lauri Uotinen

Assistant Professor of Rock Engineering

Structural mechanics meets Rock mechanics

Specialties: photogrammetry, stress inversion, kinematic analyses, scale effects, fluid flow

Chair of Kalliomekaniikkayhdistys[2] 2018-
Chair of Rakenteiden mekaniikan seura[1] 2016-2018, board 2019-

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[1] Finnish Society for Rock Mechanics, NG of ISRM
[2] Finnish Association for Structural Mechanics

Career

2025-	Assistant Professor, Aalto University
2021	Startup: AMS Solutions Oy
2019-2025	Staff Scientist, Aalto University
2019	Visiting Researcher, GTK
2018-2019	Post-doctoral researcher, Aalto University
2018	Startup: Fractuscan Oy
2012-2018	Doctoral Candidate, Aalto University
2014	Visiting Researcher, KTH
2008-2012	Rock Engineer, Kalliosuunnittelu Oy Rockplan Ltd
2006-2008	Structural Engineer, Finnmap Consulting Oy

Big picture

Rock Engineering in Finland

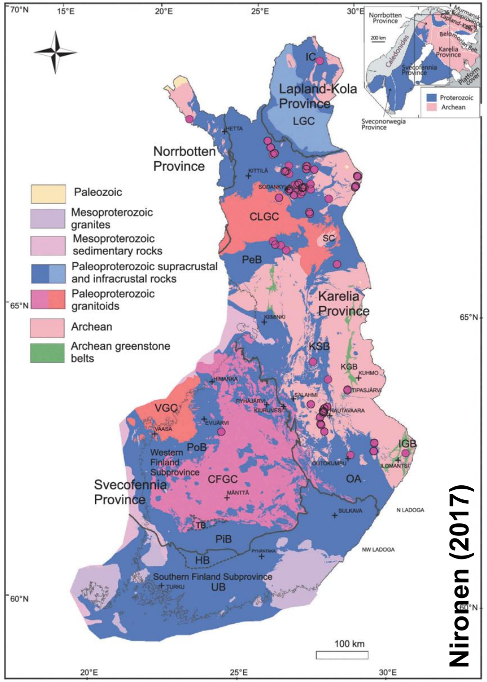
1 Enabling green transition with raw material production

2 Securing strategic raw materials with mining

3 Geological disposal of nuclear waste

4 Seasonal and short-term energy storages

5 Geothermal clean energy potential



Nironen (2017)

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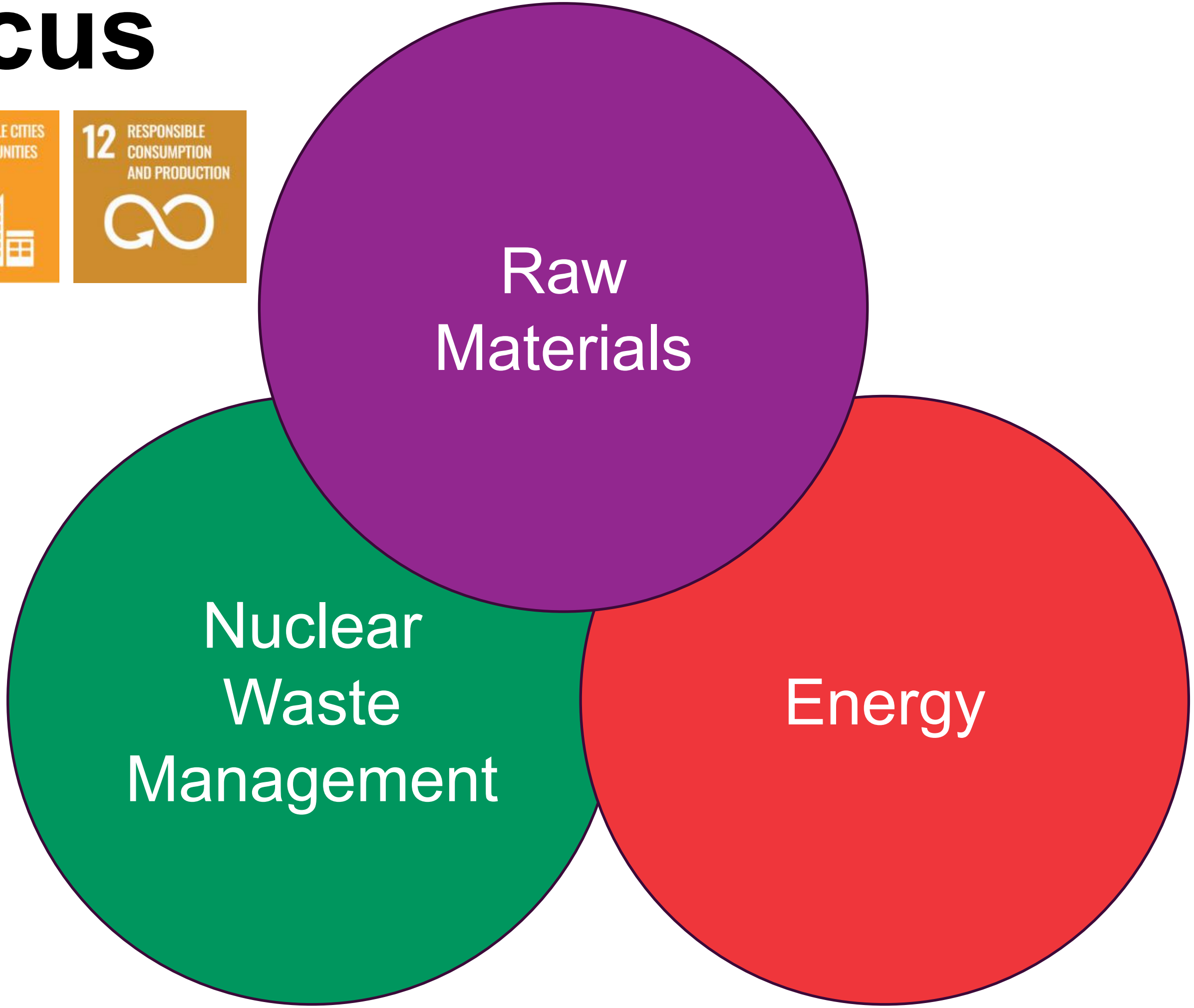
Research focus



Even bigger picture

EU Critical Raw Materials Act 2024

10 % mining within EU
40 % refined in EU
25 % of EU consumption covered internally
<65 % single country dependency

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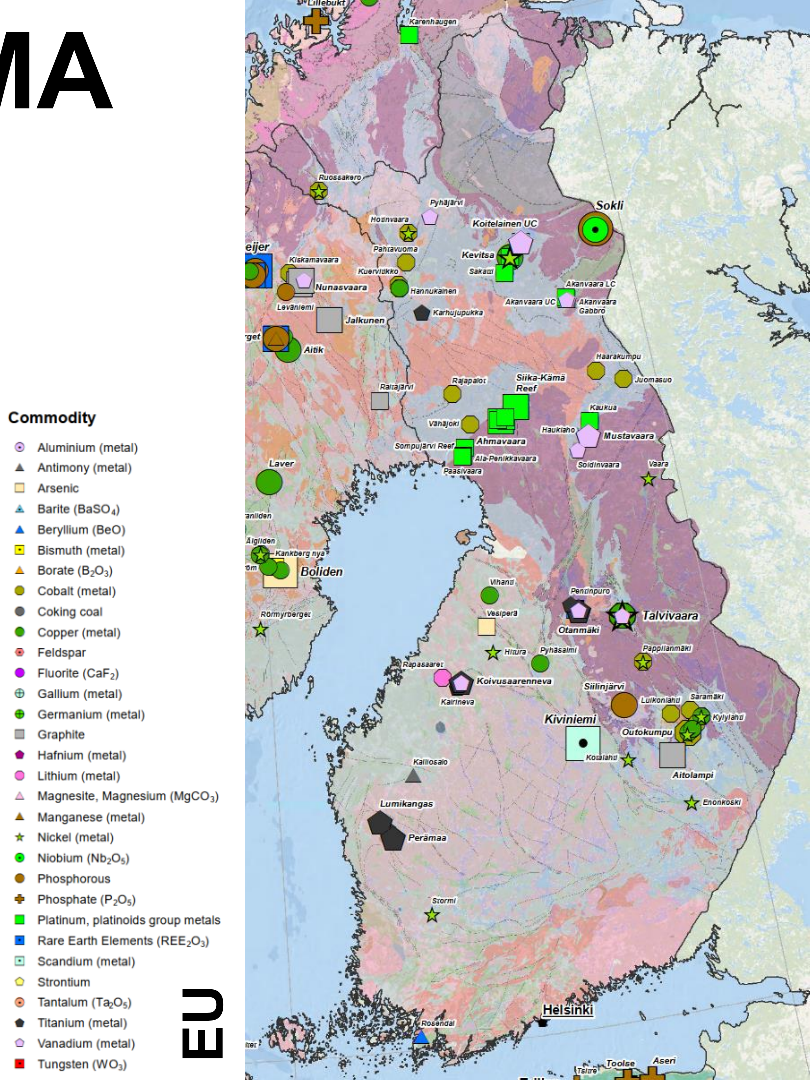
Finland’s role in CRMA

Finland is the only producer within EU of Cobolt and Platinum (Talvivaara, Kevitsa). Finland refines 10 % of global Cobolt.

According to GTK, 10 metal mines, 15 refineries, 15 recycling plants are needed by 2030 to meet CRMA.

Finnish mines produce:
Phosphate (Siilinjärvi)
Cobolt (Terrafame, Kevitsa)
Copper (Kevitsa, Terrafame)
Nickel (Terrafame, Kevitsa)
Platinum, Palladium (Kevitsa)
Feldspar (Sälpä, Kyrkoberget, Lemnästräsk)



EU

Critical 34

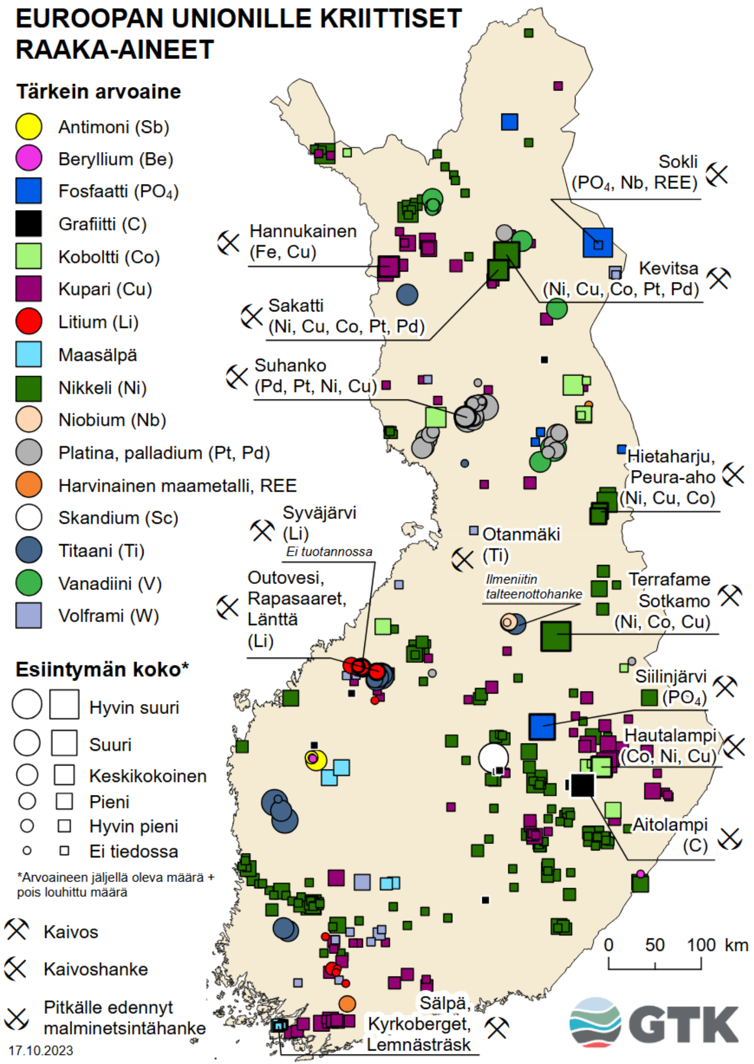
Antimony = antimoni
Arsenic = arseeni
Bauxite = bauksiitti (alumiinimalmi)
Baryte = baryytti
Beryllium = beryllium
Bismuth = vismutti
Boron = boori
Cobalt = koboltti
Coking Coal = koksi
Copper = kupari
Feldspar = maasälpä
Fluorspar = fluorisälpä
Gallium = gallium
Germanium = germanium
Hafnium = hafnium
Helium = helium
Heavy Rare Earth Elements =raskaat harvinaiset maametallit
Light Rare Earth Elements = kevyet harvinaiset maametallit
Lithium = litium
Magnesium = magnesium
Manganese = mangaani
Natural Graphite = grafiitti
Nickel – battery grade = akkulaatuinen nikkeli
Niobium = niobi
Phosphate rock = fosfaattimalmi
Phosphorus = fosfori
Platinum Group Metals = platinametallit
Scandium = skandium
Silicon metal = metallinen pii [ei siis 'silikoni']
Strontium = strontium
Tantalum = tantaali
Titanium metal = titaanimetalli
Tungsten = volframi
Vanadium = vanadiini

Strategic 17

Bauxite = bauksiitti (alumiinimalmi)
Bismuth = vismutti
Boron – metallurgy grade = metallurginen boori
Cobalt = koboltti
Copper = kupari
Gallium = gallium
Germanium = germanium
Lithium – battery grade = akkulaatuinen litium
Magnesium metal = magnesiummetalli
Manganese – battery grade = akkulaatuinen mangaani
Natural Graphite – battery grade = akkulaatuinen grafiitti
Nickel – battery grade = akkulaatuinen nikkeli
Platinum Group Metals = platinametallit
Rare Earth Elements for permanent magnets (Nd, Pr, Tb, Dy, Gd, Sm, and Ce) = kestomagneetteihin käytettävä harvinaiset maametallit
Silicon metal = metallinen pii
Titanium metal = titaanimetalli
Tungsten = volframi

Critical = important and supply risk
Strategic = energy, digital, defence, aerospace

Critical Raw Materials in Finland



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EU Strategic Projects in Finland (= max 27 months)

Sakatti (Co, Pt, Co, Ni)

Keliber (Li)

Kolmisoppi (Ni, Co)

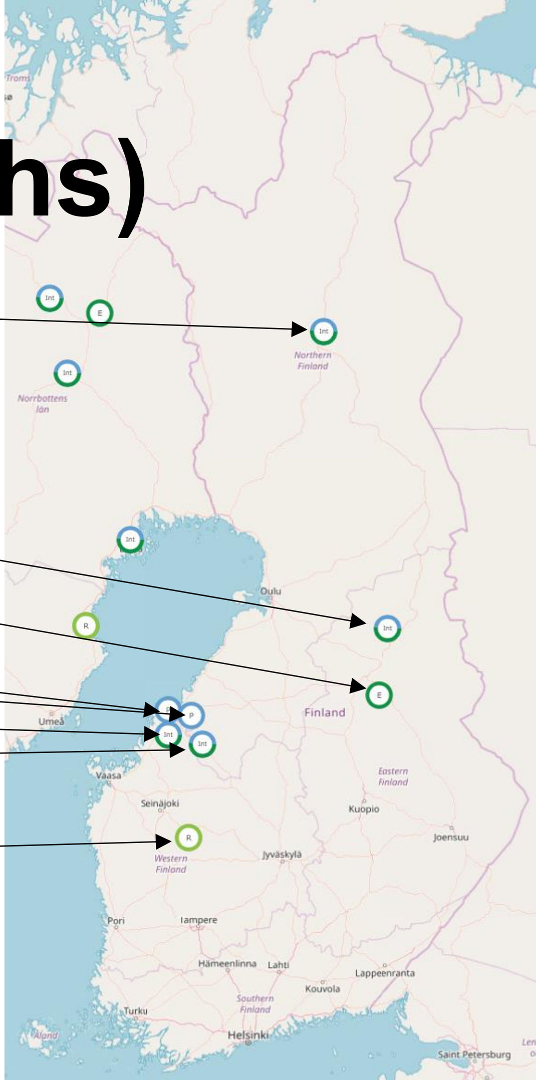
Jervois (Co)

Hycamite (C)

Keliber (Li)

Keliber (Li)

Fortum (Li, Co, Ni, Co)



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Rock Engineering in Aalto

Master’s programme in Geoengineering

Major studies 60 ECTS
Elective studies 30 ECTS

Master’s thesis 30 ECTS

Specializations: Geotechnical Engineering, Highway Engineering, Rock Engineering

Compulsory courses

Engineering Geology 5 ECTS

Geotechnics 5 ECTS

Structural Design of Roads 5 ECTS

Rock Excavation 5 ECTS

Specialization in Rock Engineering

Rock Mechanics (5 ECTS)

Rock Construction (5 ECTS)

Structural design of roads (5 ECTS)

Foundation Engineering and Ground Improvement (5 ECTS)

Advanced Soil Mechanics and Numerical Methods in Geotechnics (10-20 ECTS)

PV (exceptionally demanding) certitificate requirements

45 credits including rock technics, rock mechanics and structural geology and soil mechanics; and structural mechanics (strength of materials, concrete technology, structural mechanics, design of concrete structures)

+

6 years of working experience (of demanding design duties)

Mining Education in Aalto

European Mining Course

Aalto + RWTH Aachen (Saksa) + Montanuniversität Leoben (Itävalta)

1st semester at Aalto University (autumn 2024 and 2025) +

2nd semester at RWTH Aachen (spring/summer 2025/2026) +

3rd semester at MU Leoben (autumn/winter 2025/2026) +

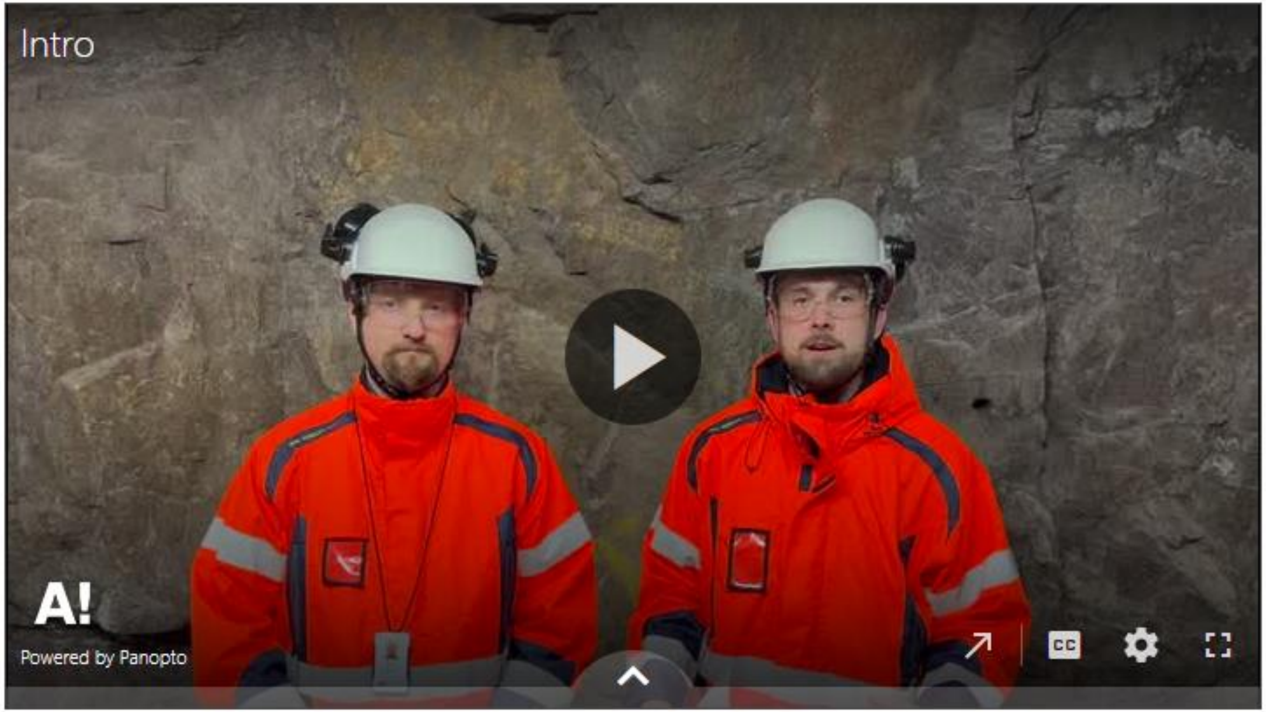
4th semester: Jointly supervised Master's thesis (spring 2025 and 2026) +

Courses offered in Aalto

Code	Name	ECTS	Period
CHEM-E6140	Fundamentals of Minerals Engineering and Recycling	5	I
GEO-E2030	Rock Mechanics	5	I
GEO-E3010	Economic Geology and Mineral Economics	5	II
GEO-E3050	Field Experience and Project in Hard Rock Mining	2	II
LC-1317	Integrated Project Communication for MSc Students (o, w) *	3	II
CHEM-E6111**	Engineering Principles for Metallurgical Processes	5	I
CHEM-E6160	Fundamentals of Pyrometallurgy	5	II
Total		**30**	

MOOC pilot: Remote Rock Mass Characterization

Try it out at: https://openlearning.aalto.fi/course/view.php?id=290



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Road Forward

Rock Engineering Trends

AI-driven design

Parametric design

Digital Twins

Circular Economy

CO2 reduction

BIM (1.1.2026)

Underground Heat Storages / LRCs for high-pressure gases (H_2)

SMRs underground

Immersive learning (VR,AR,MR)

Mining Company Thoughts

Remote Operation	Automation		Digitalization
Fleet Electrification	BEV	Reuse	Zero Waste
Fleet Intelligence	Route Efficiency Enchancements		
Net Neutral/Negative	CO_2 reduction		Parametric Design

Thank you for your attention!

Reach out and let's cooperate:

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