



# THOUGHTS ABOUT AN IDEAL VALIDATION ENVIRONMENT FOR MUOGRAPHY APPLICATIONS

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#### CALLIO LAB

Underground Center for Science and R & D



#### **Contents**

- Introduction
- What is muography?
- Validation and verification environment
  - Basic needs for a macroscale environment
  - Possibilities of a microscale environment
- Possibilities at Callio Lab, and the University of Oulu





I have tried to look at the question of the ideal validation environment for muography from both a facility provider and a user point of views. However, your thoughts would warmly welcomed.

Have your say at https://www.menti.com/u6sy7p5o75



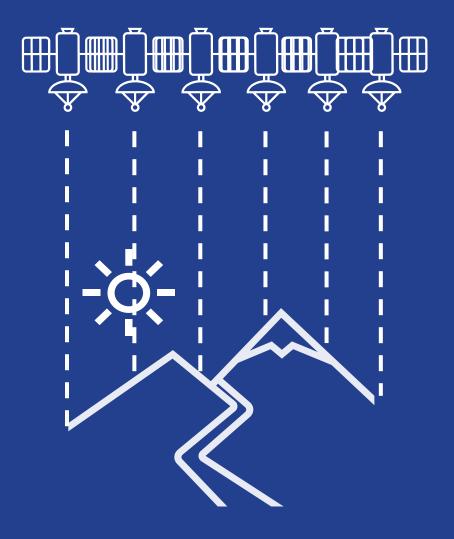




## Muography is an imaging technique to observe density anomalities within volumes







Digital Elevation Model







Digital Elevation Model



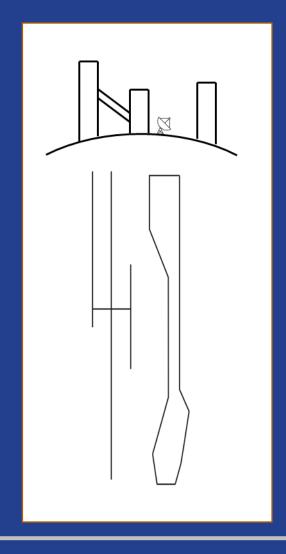




Accurate mine models



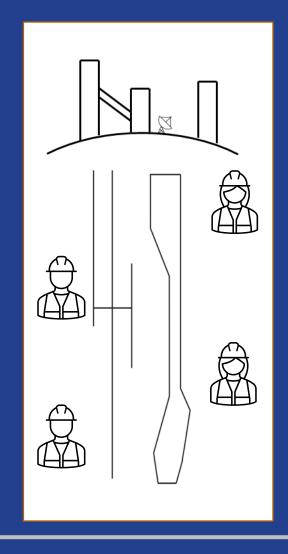




Well-known geology



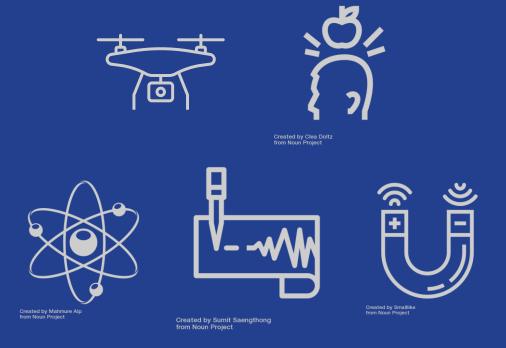




Access to various depths















Weather data





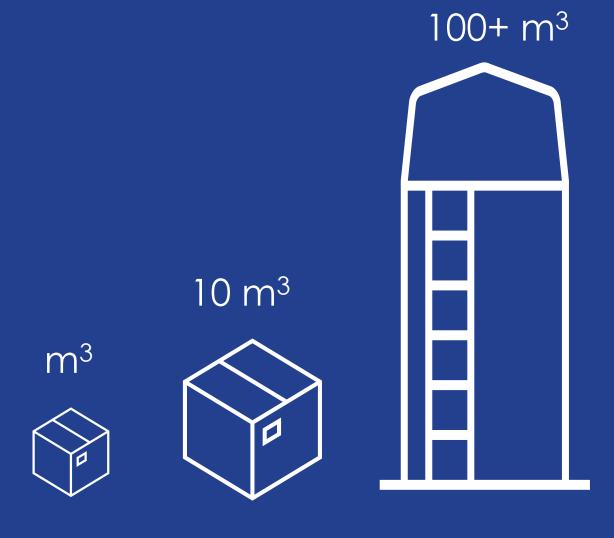


Onsite infrastructure





Possibilities of a microscale environment

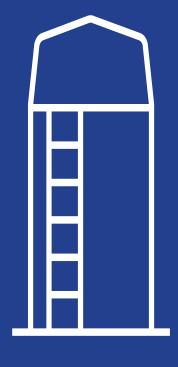


Known, controllable high-contrast targets





Possibilities of a microscale environment









Possibilities for "rapid" near surface prototyping





### Possibilities at Callio Lab

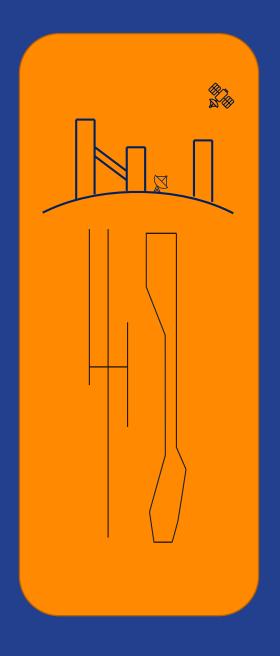




### Possibilities at Callio Lab

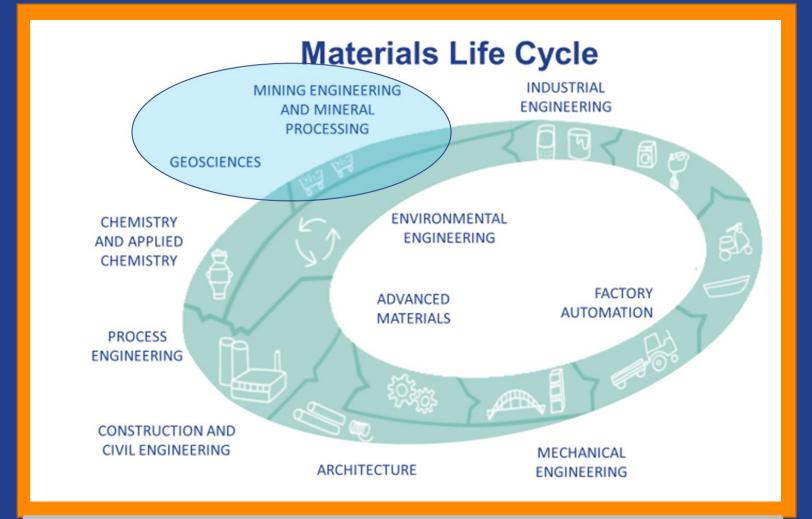
- Unique 1.4 km (~4.1 kmwe)deep mine with flat overburden.
- Access to all levels through 11.7 km long incline
- Well-known & documented geology and mine model
- Accompanying geophysical datasets
- Electricity and safety remote access capable network available
- Soon 24/7 accessibility
- Research coordinated by Kerttu Saalasti Institute, University of Oulu

We offer coordination, cooperation, networking and facilitation





# Possibilities at Callio Lab, and at the University of Oulu



Muography becoming an integrated part of research and education





# Possibilities at Callio Lab, and at the University of Oulu



MINERAL SYSTEMS and EXPLORATION

Development of environmentally friendly exploration methods

Improvement of ore models of various deposits

Advanced
technology: muons,
drones,
hyperspectral
imaging, in-situ trace
elements of heavy
minerals

Integration of geophysical and geological data set to better define targets at early stages of



**MINING** 

Development of high recovery and energy efficient mining methods

Improve excavation and blasting technologies

Improve safety: rock mass evaluation and support, rock mass fracture and bursts

Application of advance techniques:
Muography,
digitalization, AI etc.

Mine to mill - approach



**PROCESSING** 

Sustainable and resource-efficient processing

Comminution: innovations in rock breakage

Dry processing

Process automatization and real-time monitoring

Water management: recycling, onlinemeasurements

Tailngs: "secondary raw materials"

Geometallurgy



**GEOPHYSICS** 

Geophysical techniques in mining, exploration and environmental studies

Non-invasive, innovative and socially acceptable mineral exploration

Aerogeophysics, passive seismic, advanced methods of data interpretation

Microseismic monitoring in underground facilities, application of geophysical techniques for mining tailings control

Environmental studies using near-surface geophysical techniques



ARCTIC ENVIRONMENT

Development of novel solutions to monitor and reduce environmental impact of mining

Characterization of tailings ponds and hydrology

Use of natural materials in mining environments (e.g. moraine)

Increase understanding of environmental change in Arctic



TRAINING and EDUCATION

Training programmes for professionals, "Lifelong learning"

For example:

Design and upscaling in mineral processing

Promotion of social acceptance and stakeholder engagement

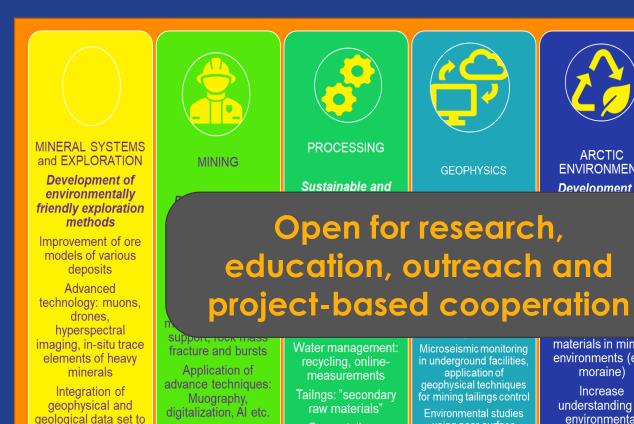
SUSTAINABILITY IN MINING OPERATIONS

Muography becoming an integrated part of research and education





Possibilities at Callio Lab, and at the University of Oulu



Mine to mill -

approach

better define targets

at early stages of

SUSTAINABILITY IN MINING OPERATIONS

Geometallurgy

using near-surface

geophysical techniques

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Muography becoming an integrated part of research and education

TRAINING and

**EDUCATION** 

Training

programmes for

professionals.

"Lifelong learning"

For example:

Design and

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Promotion of social

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**ARCTIC** 

**ENVIRONMENT** 

Development of

materials in mining

environments (e.g.

moraine)

Increase

understanding of

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change in Arctic



And what were your considerations for ideal validation environment for muography applications

Go to www.menti.com and use the code 5592 8861

In your opinion what are the key characteristics or parameters for a successful muography validation and reference environment?

Mentimeter

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Questions?







#### Thank you!

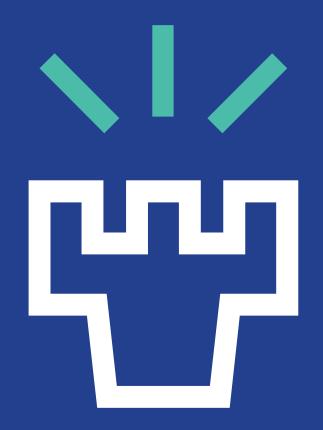
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