The research resources of the extractive industry are at your service!

The OMS Research Centre supports university education and scientific basic research in the mining sector.

The OMS Research and Development Centre is a part of Oulu University. It cooperates seamlessly with other Finnish and international research institutions and universities in the field of mining, as well as the mining industry. Come and take a closer look at our cooperation opportunities!
# Contents

## Geoscientific research

4-5  
Research team of Geosciences

6-7  
The possibilities of ore exploration

8-9  
Quaternary geology in ore exploration

10-11  
Moraine geochemistry in ore exploration

12-13  
Why is mineralogy important?

## Mining and concentration technology

14-15  
Research team of mining engineering and mineral processing

16-17  
Laboratory of mineral processing

18-19  
Continuous concentration plants

20  
Current research topics

21  
International Collaboration

22  
Major research topics in applied geophysics at OMS

24-25  
Cooperation in applied geophysical research

## Analyzers and laboratories

26-27  
Projects

28-30  
Final words

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[www.metso.fi](http://www.metso.fi)
The formation and characteristics of ores is one of the key research areas of the geosciences research team. The research focuses on magmatic Ni-Cu-PGE, Cr and Fe-Ti-V ores and gold ores, not forgetting other useful metal or industrial mineral deposits, such as massive sulphide ores, black schists and soapstone. Exploration is based on a profound knowledge of the bedrock and soil in the Fennoscandian Shield.
In Quaternary geology, applied research is related to the practical applications of Quaternary geological exploration methods, utilisation of sand, gravel and groundwater resources, as well as environmental conservation studies. Applied research is carried out in cooperation with partners such as governmental research institutes, regional environmental centres and private companies.

The main applications of Bedrock geology are related to the study of geological formations, location and exploitation of economically significant deposits, and management of a variety of environmental issues.

GTK Mintec offers industrial-scale pilot tests

- All kind of ores and secondary materials
- Capacity up to 5 t/h
- State-of-the-art process mineralogy
- Bankability

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Contact us: mineraalitekniikka@gtk.fi
The possibilities of ore exploration

There will be a great need for raw materials also in the future. There are enormous areas in the world with unmapped ore potential.
The OMS Research Centre participates in researching and developing new methods for discovering ore. Studying bedrock and soil samples requires collecting samples and conducting chemical analysis on them. Thick soil covers, mires, weathered bedrock, arctic environment and climate change make ore exploration challenging. In addition, the environment in the northern region is usually very vulnerable and often protected.

We meet the challenges of ore exploration with environmentally friendly solutions. There are many ways of sampling, the most common ones being percussion drilling, survey excavations and digging a hole. Sampling concepts are being developed continuously, and the aim of the new methods is to collect bedrock and soil samples at the same time. The impact of surveys can be minimised with careful planning, selection of site and aftercare of the site.
Quaternary geology in ore exploration

Geochemical and heavy mineralogical soil surveys are basic methods in Finland.

In terms of ore exploration it is important to know the bedrock and its geochemical and geophysical properties, soil formations, layer order, structure, transport directions and the circumstances in which the survey and sampling will be conducted.

In addition to the established sampling methods, we use many existing materials, including:

- laymen's samples and surface boulder mapping
- moraine geochemical material
- geochemistry of streams and groundwater and the geochemistry of stream sediments
- heavy geochemical material.

With the materials, the OMS research centre can create predictions of the most favourable ore exploration sites and create cost savings by allocating research and sampling to limited areas.
Geochemical ore exploration surveys are based on using secondary dispersion fan of elements. Traditionally, heavy minerals have been identified visually using a microscope. Gravity separation methods used for minerals include panning, spiral separators, Knelson concentrators, vibrating tables, heavy liquids, and hydro separation. Heavy mineral samples can be taken from, for example, glaciofluvial sediments, fluvial sediments, paleoplacers, weathered rock and moraine.
Indicator mineral survey of heavy minerals is a new technology that expands the utilisation possibilities of the heavy mineral methods. Indicator minerals can also be identified with hyperspectral surveying and, for example, the XRD method (REE investigation).
Ore microscopy

- Ore microscopy is a difficult ‘art’: a tendency to rely on experience
- The microscopic study of ore minerals largely involves the use of reflected light
- Both transmitted and reflected light microscopy to study ore deposits
- Reflected light microscopy as a qualitative technique
- Still involves careful evaluation of mineral properties to enable identification

Applications

- A useful and accurate way of studying the reactions and processes that form ore deposits
- Invaluable in the development of efficient means of processing ores through the milling, separation and refining required to produce a final raw metal product (Geometallurgy)
- Essential pre-preparation for more sophisticated instrumental assessment techniques: SEM, EPMA, LA-ICP-MS, SIMS, etc.

Why mineralogy is important?

- Elemental data doesn’t give enough information about the rock that contains valuable minerals
- For example, the hardness of the rock depends on the minerals the rock is made of -> affects milling and separation
- Ore mineral occurrence, massive vs. disseminated -> Ore grade
- Some of the valuable elements are in the gangue minerals and cannot be recovered -> important information for mine feasibility evaluation
- Beneficiation process planning benefits from mineral data -> Geometallurgy
The mineral processing research team is responsible for ideal enrichment processing and its research, and develops innovative tools and online technologies for the measurement and optimisation of mineral processing in close cooperation with the mineral industry and education partners. The methods are utilised in applications such as material feed and treatment in mineral processing plants, clean technologies in raw-material processing and waste management.

The mining technology laboratory researches, among other things, phenomena related to blasting and their possibilities in mining operations. We use, for example, the Split Hopkinson Pressure Bar.

One task for Mining engineering is to make smooth and safe slopes. Good design using rock mechanics and mining knowledge saves money and increases safety.
Kaivosteollisuus

Ennen kaikkea kaivos.
Laboratory of mineral processing

The OMS Research Centre has state-of-the-art research equipment for teaching and research purposes.

There is, in addition to all the necessary measuring instruments and analytical devices, research equipment used in the grinding process, as well as the equipment needed for all different separation techniques. The devices include an automatic froth flotation cell, particle size analyser, leaching line, a Knelson concentrator, XRF, Bond Index Mill, and a magnetic separator. The high-end analysers are located at the microscopy and nanotechnology centre.
Can your valuable material be separated? Let us find out!
Continuous beneficiation plants

The OMS Research Centre has continuous and automatic concentration facilities, which are unique even on a global scale and benefit the entire mining sector.
The concentration plants include an automatic crushing mill, froth flotation beneficiation, gravity concentrator, magnetic separation equipment, cleaning and recycling units for process water, as well as a laboratory-scale continuous leaching line.

The plants are automatic and modular, enabling equipment changes without adverse effects to process automation. The continuous beneficiation plants enable industrial research from process mineralogy to sensor development. The concentration plants are connected to the OMS Research Centre's modelling software, enabling the simulation of a running process.
Mineral Processing – current research topics

- Upscaling in mineral processing – utilising existing facilities and co-operation with e.g. GTK Mintec.
- Fine flotation, flotation chemistry
- Optimisation of the comminution chain; link to geometallurgy
- Water and tailings management (process waters, solid tailings)
- Lifelong learning projects (EIT Kic Raw Materials)

International Collaboration
- Cooperation in research and education with the Luleå University of Technology
- Nordic Mining School - co-operation with Scandinavian universities
- Research cooperation in geosciences with several foreign universities or research institutes
- Research cooperation in engineering with several foreign partners
- Close industrial collaboration with mining companies and technology providers
Major research topics in applied geophysics at OMS

1) Advanced methods of geophysical exploration - seismic reflection and refraction, passive seismic interferometry with application to shallow subsurface imaging, 3D modelling and inversion, multi-method ground-based measurements and their integrated interpretation

2) Mining geophysics: geophysical measurements in mines, microseismic monitoring, multi-method measurements

3) 3D geophysical modelling and inversion

Geophysics
- Modern sensor technologies
- Computing technologies
- Big data
- 3D/4D visualisation tools
- Numerical modelling and inversion
and much more...

Innovations in seismic instrumentation:
1) Wireless data harvesting in the field
2) New types of seismic sensors

ETSIMME JATKUVASTI OPISKELIJOITA JA AMMATTILAISIA MONIPUOLISIIN TEHTÄVIIN.

TÖIHIN TAPOJÄRVELLE
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www.tapojarvi.com
Cooperation in applied geophysical research

Cooperation in applied geophysical research of the Oulu Mining School with the geological survey of Finland.

What the OMS is interested in:
1) To get access to high-quality geophysical data for research and education
2) To continue its own research in advanced methods of exploration (passive seismic methods, 3D seismic interferometry, 3D imaging methods, joint inversion of multi-method geophysical data)

The OMS contribution to the cooperation
1) Logistical support for common projects from Oulu Mining School and Sodankylä Geophysical Observatory
2) Multichannel seismic equipment, equipment for EM and gravimetric measurements, petrophysical laboratory equipment
3) Planning of seismic experiments
4) Joint research and networking
5) Expertise in management of project data (data policy, archiving etc.)
6) Experience in regional geophysical studies in the Fennoscandian Shield (deep seismic studies, 3D modelling)
INNOVATE WITH US

The breakthroughs that truly create customer value do not come automatically. Innovation drives everything we do. From developing new technologies to revolutionizing productivity, we know that there is always a better way.

Oy Atlas Copco Louhintatekniiikka Ab
www.atlascopco.fi
Analyzers and laboratories

THE CENTRE OF MICROSCOPY AND NANOTECHNOLOGY AT THE UNIVERSITY OF OULU www.oulu.fi/mnt

Electron microscopes
- Focused Ion Beam, FEI Helios
- Energy Filtered Transmission Electron Microscope, Leo (EFTEM/EDS)
- Transmission Electron Microscope, JEM-2200FS (TEM/STEM)
- Field Emission Scanning Electron Micr. Zeiss Ultra
- Field Emission Scanning Electron Micr. Zeiss Sigma
- EPMA Microanalyzer, “Microprobe” (EPMA)

Thin film processes
- Plasma Enhanced CVD processing (PECVD, Oxford 80)
- RIE-processing (RIE) Oxford 80
- UV-micromachining lasers (several)
- Evaporation/sputtering/e-beam (Torr International)
- Lithography line, SUSS mask aligner, SUSS spinners, wet benches
- Other cleanroom/packaging processes e.g. bonding, probing
- Profilometer, DekTak
- Photolithography mask fabrication
- Several evaporators (metal, carbon)

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Spectrometers
- Ellipsometer, Horiba Jobin-Yvon UVISEL-VASE
- micro-Raman, Horiba (LabRAM)
- Photospectrometer CARY 500 (PSM)

X-ray analysis devices €/h
- X-ray photoelectron spectroscopy (XPS), ThermoScientific ESCAlab
- X-ray fluorescence, Bruker
- X-ray fluorescence, PanAnalytical
- X-ray diffractometer, Siemens
- X-ray diffractometer, Rigaku

Other microscopes
- Acoustic microscope (CSAM)
- X-ray microscope, FEIN Focus (XRM)
WELL-EQUIPPED LABORATORIES IN OULU MINING SCHOOL

Laboratories for geosciences
- Sawing
- Crushing
- Grinding
- Sieving
- Polished thin and thick section
- Preparing an XRF sample
- Geochemistry
- Separation
- Ore microscope
- GIS and Surpack

Laboratories for rock engineering and mineral processing
- Comminution
- Flotation and leaching
- Rock engineering

Continuous research plants
- Three-level crushing
- Minipilot, beneficiation plant
- Gravity separation / Spiral
- Magnetic separation
- Process water and recycling
- Control room and servers
- Simulators for the process

Mill linings
Individual solutions for wear and corrosion protection

www.teknikum.com
GEOPHYSICS AT OMS – RECENT AND ON-GOING PROJECTS:

- “POLENET/LAPNET - a multidisciplinary seismic array experiment in northern Fennoscandia during the international polar year 2007–2009”.

- Project: SEISLAB: a new laboratory of applied seismology at the University of Oulu (2011–2014)

- Upgrading the Finnish National Seismic Network: a subproject of FIN-EPOS, a part of a consortium project funded by the Academy of Finland in 2015–2017 (FIRI 2014 Research Infrastructure Project).

- Impact of extreme weather events in the Arctic on technological system, critical facilities and urban environment. Funded by the University of Finland in 2017-2020.

- EPOS IP: Implementation Phase of EPOS (European Plate Observing System). A long-term plan to facilitate integrated use of data, data products, and facilities from distributed research infrastructures for solid Earth science in Europe. The implementation Phase project is funded under the European Commission’s Horizon 2020 programme and runs from 2015–2019. University of Oulu (UOULU) is one of 26 beneficiaries and E. Kozlovskaya is EPOS coordinator at the UOULU.


- Development of passive seismic interferometry for the purpose of mapping 3-D shallow structure of subsurface (2017-2018)
LOSER OF ICE IN THE ARCTIC SYSTEM – GEOLOGICAL PERSPECTIVE OF GLOBAL ENVIRONMENTAL CHANGE

The objectives of this research project are to produce important threshold values in geochemical and sedimentological information on environment and related loss of ice in the North.

This will be used to evaluate glacial dynamics, loss of ice and related meltwater plumes in time scales from hundreds to hundreds of thousands of years.

Subproject 1: The Eurasian Arctic ice-sheet distribution and ice streaming during melting episodes in the Arctic land environment.

Subproject 2: Mineralogical and radiogenic isotope proxies and source area fingerprints in sediments for those meltwater releases and sediment distribution in the Arctic marine environment.

PROCHAINE (2017–2019) – DESIGN AND UPSCALING IN MINERAL PROCESSING

PROCHAINE draws upon the latest expertise in the field; and covers the whole process development chain - from ore mineralogy and bench scale testing to continuous mode process testing and process optimization in a state-of-the-art pilot plant.

Goal
To develop an advanced level, practical training programme on the topic “Design and upscaling in mineral processing”. After finishing the training programme the learners have a good fundamental understanding and knowledge in design and scale-up in mineral processing, and the factors affecting the functionality of the process. The whole area will be considered from both theoretical and practical points of view.

Target group of learners
Professionals already working in the mining sector who are keen to learn more about mineral processing.

Co operation
PROCHAINE is funded by EIT RawMaterials. The partners of the project are the University of Oulu/Oulu Mining School, Luleå University of Technology, Geological Survey of Finland/ GTK Mintec, Outotec and Schneider Electric.

The outcome of the project will be a commercial product that can be offered for the industry not only in Europe but also worldwide.
**MINESENSE (Q1/2013–Q4/2014)**

to develop measurement and plant wide control solutions for mineral beneficiation process with the aim of sustainability.

**User needs**
- To minimise environmental and social impacts of mining, simultaneously maintaining production efficiency

**Approach**
- Measurement and control technologies to address productivity and sustainability

**Benefits**
- Saving in raw material, chemicals, water and energy use
- Improved product quality
- Early detection of environmental risks and preventive actions

**Users**
- Mining companies
- Automation and Instrument Manufacturers

**INDIKA – Automatic identification of indicator minerals when exploring critical minerals**

The aim of the project is to study the applicability of new automatic and on-site indicator mineral surveys for finding critical minerals and metals.
- the ERDF project (2016–2018)
- Research partners: GTK, Lapland University of Applied Sciences and Oulu University.
- Investors: Oxford Instruments, the Finnish Mining Association and the Gold Prospectors Association of Finnish Lapland.

**OMS INTERNATIONAL MASTER PROGRAMME**

The Master’s degree programme in Economic Geology is organised by Oulu Mining School for international students. It consists of a total of 120 ECTS credits including a 35 credit Master’s thesis and takes two years of full-time study.


IbD® will create a holistic platform for facilitating process intensification in which solids are an intrinsic part.

**Problem**
- Need for faster, more efficient, and environmentally friendly processes.

**Objective**
- To intensify grinding circuit operation and to bring the “Quality by Design, QbD” approach from medical industry to process industry.

**Solution**
- New control strategies and model on-line adaptation. Intensification of grinding circuit with coarse flotation.

**Benefits**
- Improved yield of enrichment process. New control methods lead to better understanding and control of the grinding process.

**ENSACO – Energy and Chemicals Saving Flotation Concentration**

**Needs**
- Energy and chemicals saving flotation concentration concept starting from crushing and grinding is needed
- The most important development objectives are to decrease energy and chemical usage, to find optimal ways to control crushing and grinding (taking into account the mineralogy of feed ore) and the removal of the fines and the gangue minerals as early as possible

**Approach**
- General view on the effects of flotation results by using optimised crushing and grinding
- Introduced concept improves the economy of flotation concentration

**Benefits**
- Mineral-based crushing gives a good basis to perform process stages according to the feed material and therefore optimally
- The concept gives additional information to design the crushing process and equipment

**Users & Competition**
- Mines, technology companies, researchers
- The concept to develop is based on sustainability
- Better quality and improved production rate, less fewer environmental emissions
BusinessOulu supports economic growth of the Oulu region mining industry

Mining industry provides significant business opportunities in the Northern Finland. There are currently over 100 companies in the region operating in mining industry and providing services directly for mining industry.

Cooperation between BusinessOulu, regional companies and educational and R&D institutions focuses on

- increasing mining industry investment potential
- building national and international networks and partnerships
- developing mining industry clusters
- promoting and improving IoT and digitalization for the benefit of mining industry

In addition to our research in our state-of-the-art laboratory and our development projects, we also offer you, our trusted partners, training programmes.

In our continuous concentration plants we will train you, industrial actors, representatives of the extractive sector, and officials to enrich (in both theory and practice) on courses that can last from a few days to two weeks.

With rocking regards

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