Geomaterials Research at GTK

Mineral Processing and Materials Research Unit

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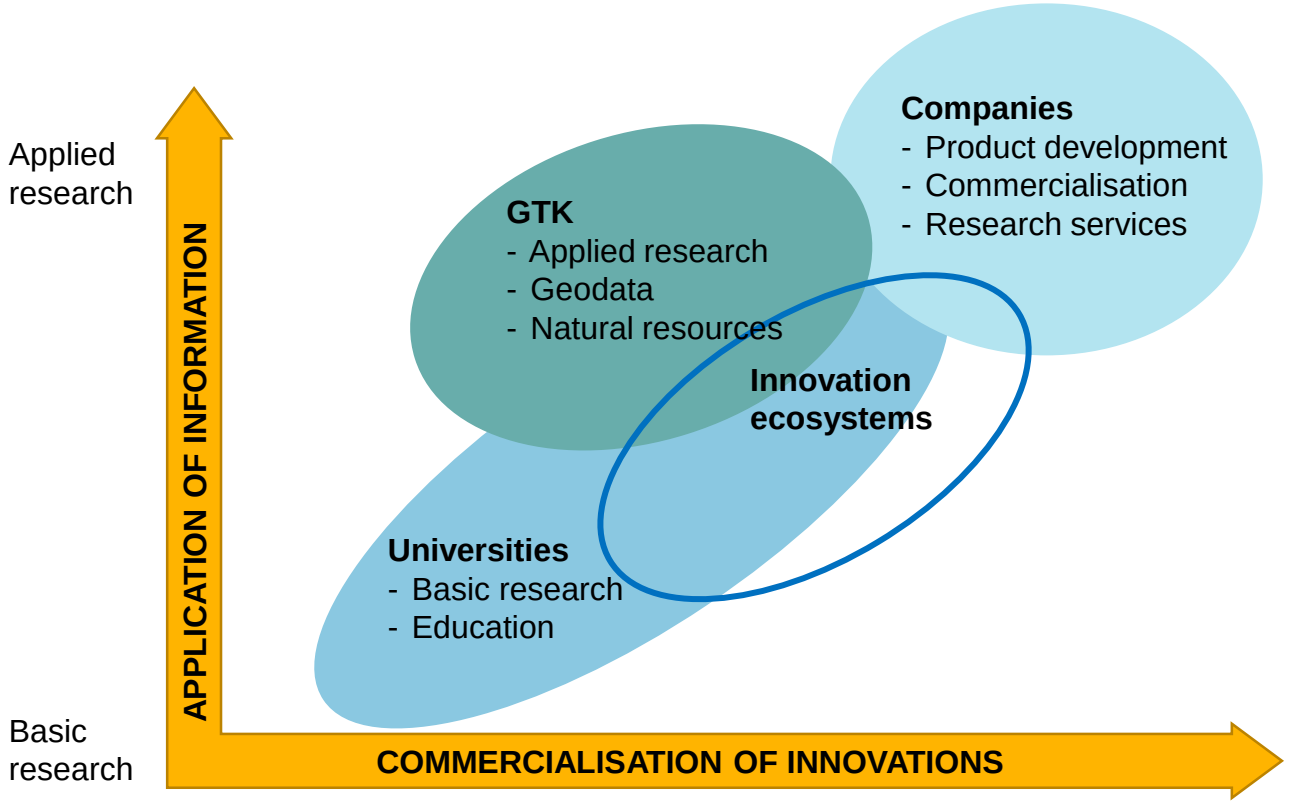
GTK's Role in the Research and Innovation Sector



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Geomaterials: Definition

- Primary and secondary raw materials
- All mineral based materials
- Naturally occurring
  - Rocks, sediments and soils
- Refined, processed, manufactured and recycled materials
  - Cement, concrete, slag

Photo: Kari A. Kinnunen

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GTK Offices and Units

Geoenergy
Engineering Geology and Land Use
Subsurface Construction and Waste Disposal
Environmental Geology
Marine Geology
Ore Geology and Mineral Economics
Mineral Resources
Industrial Minerals
Mineral Processing and Materials Research (MMA)
Peat Resources
Groundwater
Applied Geophysics
Industrial Environments and Recycling
Regional Geodata and Interpretation
Corporate Geodata Management
Digital Products and Services

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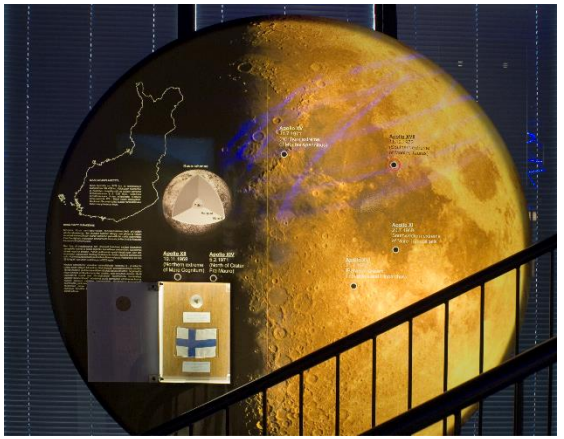
Mineral Processing and Materials Research Unit

- Mintec, Outokumpu
  - Pilot plant
  - Mineral processing laboratory
  - Mineralogical laboratory
  - Staff ca 35
- Research Laboratory, Espoo
  - Mineralogical laboratory
  - Isotope geology laboratory
  - Staff ca 20
- Risto Pietilä, Head of Unit



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Advanced mineralogical and materials characterization
from nanoscale to kilotons

Entire research chain from ***nanoparticles to micron scale major, trace and isotope compositional studies to bench top scale method testing to tens or hundreds of tons pilot scale work*** *for proof of concept. Long experience with different kinds of ore types including base metals, precious metals, industrial minerals, rare earth elements and diamonds.*

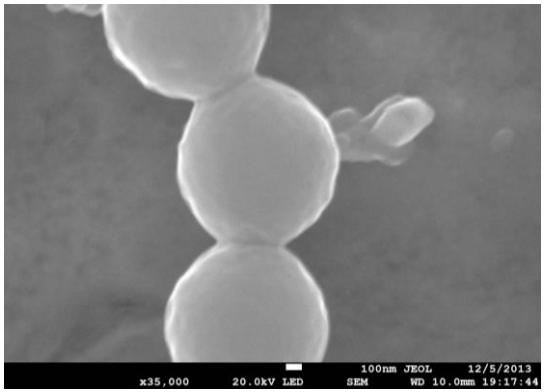
Mineralogical research
- Process samples, ore deposits, secondary and recycled materials
- State-of-the-art techniques MLA, FE-SEM, EPMA, XRD, XCT

Isotope geology research
- Nearly all types of samples, solids and liquids
- State-of-the-art techniques SC-ICP-MS, MC-ICP-MS

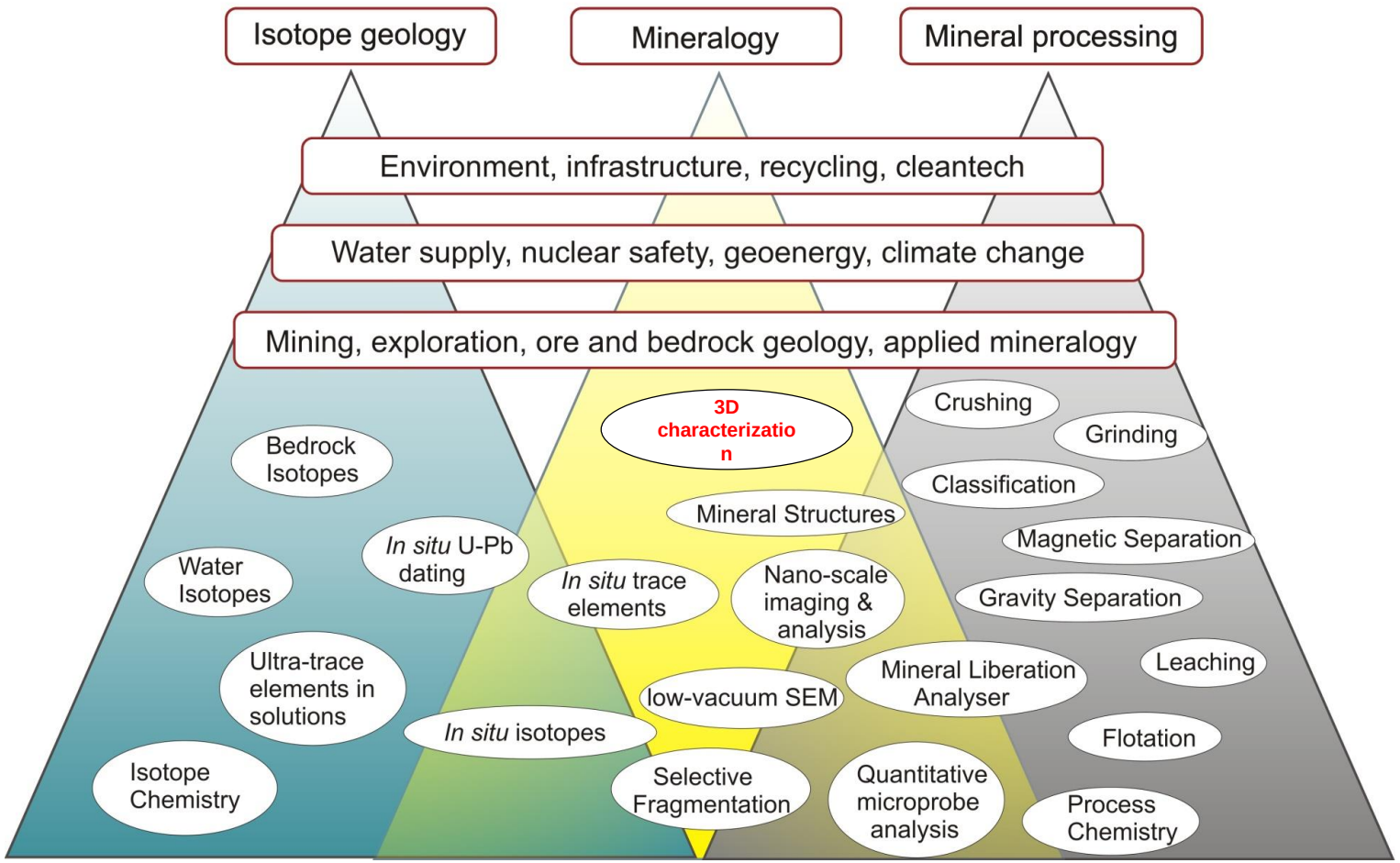
Bench scale tests
- All common beneficiation methods

Mini-pilot tests
- Feed capacity range 10-50 kg/h
- Typical sample size 400 – 2000 kg

Pilot plant tests
- Feed capacity range 0,2 – 5 tons/h
- Typical sample size 20 – 300 tons (max 15 000 tons)

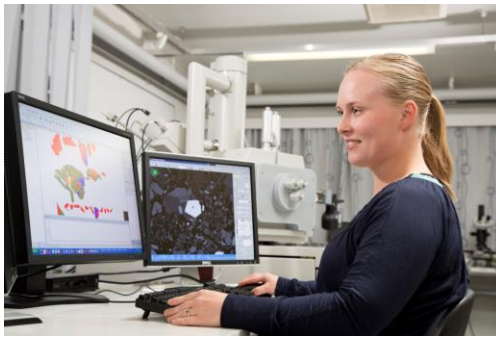


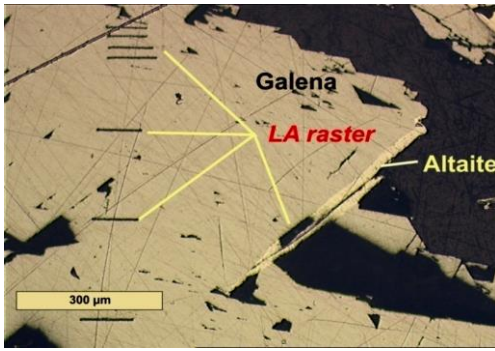
GTK MMA Laboratory - A complete applied geosciences analytical facility



Electron optics - X-ray diffraction - Radiogenic isotopes - X-ray tomography - Selective fragmentation

- New research applications: Multidisciplinary approach
- Value adding: Collaboration with universities and other research organizations
- Expertise and laboratory knowhow to benefit the Client: Processes, materials, products, technologies





Mineralogy and Isotope Geology Laboratories

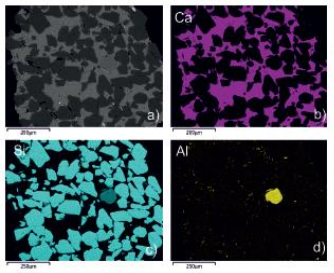
Espoo

- XRD: mineral identification, clay structural studies
- LV-SEM-EDS and FE-SEM-EDS: high resolution imaging, automated mineralogy
- EPMA: quantitative major and minor elements
- selFrag: High voltage pulse power for selective fragmentation
- (LA)-MC-ICP-MS: High precision radiogenic isotopes in solutions and in solids
- (LA)-SC-ICP-MS: Trace elements to ppt LOD in solutions and ppb LOD in solids
- Automated ion chromatograph for cations
- Cavity ring-down spectroscopy system: Stable isotopes on water
- **High energy microCT scanner: 3D scanning of solids**
- Mineral separation and clean chemistry laboratories & technical facilities for sample preparation

Outokumpu

- XRD: mineral identification
- MLA and FE-SEM-MLA/QEMSCAN: high resolution imaging, advanced process mineralogy
- Technical facilities for sample preparation
- New in 2018: Raman microscope







Mineral Processing at Bench Scale

- Comminution and classification
- Flotation
- Hydrometallurgy
- Magnetic separation
- Gravity separation
- Dewatering
- Process chemistry

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Mini Pilot Plant

- First study in a continuous process after bench scale results
- Sample size 400 – 2,000 kg drill cores, ore sample etc.
- Sample pre-crushed to feed size of 3 - 6 mm
- Facility was originally designed and constructed in a sea container
- Feed capacity 10 - 50 kg/h

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Pilot Plant

- Processes can easily be adapted to capacity ranges from 0.2 tph up to 5 tph
- Sample sizes typically from 20 to 300 tonnes (max > 15 000 tonnes)
- Plant automation and process control of a high level, together with automatic sampling systems, ensure the highest quality results
- To conduct testwork for feasibility studies of new ore deposits
- To conduct process development for existing plants
- To develop comminution and benefication methods, and equipment for industry
- To generate process information for plant design
- Bankable feasibility studies

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Networks

- OREVAL, EIT Raw Materials
  - Network of mineralogical laboratories with complementary know-how for advanced geomaterials characterization
- METNET, EIT Raw Materials
  - European Pilot Plant Network for Extractive Metallurgy and Mineral Processing
- PROMETIA
  - An international non-profit association promoting innovation in mineral processing and extractive metallurgy for mining and recycling of raw materials.

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Suomen Geotieteiden Tutkimuslaboratorio (SGL)
Finland Geosciences Research Laboratory (SGL)

Geological Survey of Finland (GTK) • Aalto University • University of Helsinki • University of Turku • Åbo Akademi University • University of Oulu

Field Emission (High Resolution) Scanning Electron Microscope

Single Collector High Resolution Inductively Coupled Plasma Mass Spectrometer

Multi-Collector High Resolution Inductively Coupled Plasma Mass Spectrometer

2016: 19 peer-reviewed articles

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MMA: Current Research Projects

Project	Full title	Funding	MMA's role
EURARE / J. Yang	Development of a sustainable exploitation scheme for Europe's Rare Earth ore deposits	EU FP7	Mineralogical characterization of advanced European REE ores, and beneficiation technique development in laboratory and pilot plant scale for REE recovery.
MSP-REFRAM / J. Yang	Multi-Stakeholder Platform for a Secure Supply of Refractory Metals in Europe	EU H2020	Providing technical data for EU about mining and mineral processing technologies and innovation studies of five refractory metals.
FAME / T. Korhonen	Flexible and mobile economic processing technologies	EU H2020	Development of laboratory and pilot scale processing methods for Li-pegmatite and skarn type ores
CMECO / J. Marmo	Critical Metals Ecosystem	TEKES	Investigation of incinerator slags: raw material potential, improvement of environmental qualification.
REE-PG / J. Yang	Rare earth recovery from phosphogypsum	Academy of Finland	Mineralogical characterization of phosphogypsum (PG) and investigations on reprocessing of PG for REE recovery.
SEXUM / R. Neitola	Advanced technologies for sustainable exploitation of uranium-bearing mineral resources	Academy of Finland	Development of laboratory scale techniques for controlling uranium in beneficiation of gold ores.
EWT CYNCOR / M. Niemistö	Electrochemical water treatment for cyanide and nitrogen compounds removal	EIT Raw Materials	Project co-ordination and laboratory work. Electro-chemical water treatment for the removal of cyanide and nitrogen.

Current Research Projects: Jointly with other GTK Units

Project	Full title	Funding	Project management at GTK	MMA's role
INDIKA	Automated indicator mineral identification methods for the critical mineral exploration	ERDF	Regional Geodata and Interpretation /P. Sarala	Testing and development of indicator mineral processing methods and automated identification protocols.
KAIHAME	Mining waste management methods	ERDF	Industrial Environments and Recycling / P. Kauppila	Mineralogical characterization of tailings and waste rocks. Improvement of environmental qualifications of mining wastes by laboratory scale mineral processing.
CERATAIL	Novel synthesis methods for porous ceramics from mine tailings	Academy of Finland	Industrial Environments and Recycling / M. L. Räisänen	Mineralogical characterization and laboratory scale beneficiation tests of tailings to recover minerals used in ceramics industry.

Foreign Projects

Country	Project	Project manager	Funding	MMA's role
Ethiopia	Improving the Food Security of Ethiopia: Assessment of Carbonate Rock Resources for Acid Soil Amendment and Balanced Application of Lime and Fertilizers in Oromia Region	Tegist Chernet	MFA, IKI	Project management. Mineral analytics. Grinding experiments. Training.
Cameroon	PRECASEM (Realization of a geological and geochemical mapping program and the implementation of an GIS database in Cameroon, within the framework of the Project to Strengthen Capacities in the Mining Sector)	Michael Staudt	WB	Geochronology (U-Pb dating of rocks)

Thank you for your attention!

Kiitos!

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