THE DEGREE PROGRAMME IN GEO-SCIENCES

The geosciences include all branches of science that study the structure, composition, evolution and dynamics of the planet Earth and its natural mineral and energy resources. The social significance of geoscientific research has increased recently due to many factors, including the growing world population and the expanding global economy, resulting in an increasing demand for new raw materials and, at the same time, the enhanced awareness of the significance of environmental protection, mitigation of natural and anthropogenic hazards and sustainable development of the society.

The main aim of geoscientific research is to understand the Earth’s ancient and current geological processes and related factors affecting the well-being of mankind. Geologists and geophysicists study different geological processes operating within and on the Earth, such as magmatism, metamorphism, deformation, erosion and sedimentation, and geological formations which are and were generated by these processes. Earth materials are constantly processed and recycled by physical, chemical and biological processes of our dynamic planet and anthropogenic activities, which provides investigators with many challenging questions.

Fundamental research focusing on the origin and evolution of the bedrock and its sedimentary cover provides a scientific basis for the research of renewable and non-renewable natural resources. Environmental research and environmental monitoring has recently attracted much attention along with the more traditional research fields such as mineral exploration and geological mapping. Also, the interest in the environment and natural resources of Arctic areas is currently strongly growing.

The degree programme in Geosciences is the other of the two degree programmes in Oulu Mining School. The other one is the degree programme in Mining Technology and Mineral Processing. The aim of the degree programme in Geosciences is to provide students with the competence to work as experts in different fields of geosciences in the public and private sector. It guides them to understand the action of geological processes and the mechanisms of formation of different geological formations. Teaching helps to develop skills that are needed in mineral exploration, mapping and exploitation of natural resources and also in their protection. More and more geological and geophysical information is needed in environmental planning and research and solution of environmental problems. The research field is multidisciplinary and therefore useful minor subjects include Chemistry, Physics, Geography, Biology, Mathematics, Information Sciences, Process, Water and Environmental Technology, and especially Mining Technology and Mineral Processing.

Field and laboratory training and summer work form an important component of geological and geophysical education, complementing theoretical studies. Among the general learning outcomes are various communicational and problem solving skills. Other typical competences in the field are: 1) adoption of four-dimensional...
time-spatial visualisation skills in understanding processes that deform rocks, 2) capability to integrate versatile information obtained from the field or laboratory, and skills to synthesise and perform modelling. 3) ability to acquire diverse and comprehensive information on currently operating environmental processes, and 4) ability of develop a profound understanding on the needs of the society to exploit and protect natural resources. Internationalisation is a self-evident part of the training and future work relations, as the boundaries of geological formations do not follow those between countries or linguistic regions. The education thus creates good possibilities for the graduated student to move abroad either to continue his/her studies at other universities or work for international exploration and mining companies.

In Oulu Mining School, teaching and research of geosciences is distributed amongst the following four main subjects:

- Geology and Mineralogy
- Quaternary Geology
- Geochemistry
- Geophysics

**Geology and Mineralogy** is the study of the solid Earth, the materials which it is made of, including minerals, rocks and geological formations, and the physical, chemical and biological processes responsible for their generation. **Mineralogy** focuses on the structure, composition, occurrence and utilisation of minerals and forms the foundation to geological research. **Regional Geology** deals with general characteristics of a given area and the evolution of the bedrock. Using field studies and geochronological tools, geologists determine and date the time sequences of events in the Earth's history, from the beginning to the present time. In **igneous petrology**, the focus is on understanding the nature and origin of rocks crystallised from molten rock or magma, while **sedimentary and metamorphic petrology** deal with the nature and origin of sedimentary and metamorphic rocks, respectively. **Structural Geology** is the study of mechanical deformation of the bedrock and the resultant three-dimensional structural forms. An important branch of Geology and Mineralogy is **Ore Geology** dealing with the characteristics and genesis of different ore deposits, forming a basis for mineral exploration. Metals and minerals are essential for the sustainable development of the society, and their geological occurrence and exploitation have been chosen as one of the key topics in our department.

In **Quaternary Geology**, the focus is on the surface of the Earth's crust, which largely comprises different types of sediments. These were mainly formed during the youngest geological time period of the Earth's history, the Quaternary period, explaining the name given to this field of research. The sub-fields of Quaternary Geology include **Physical Geology** and, especially in Finland, its branch dealing with **Glacial Geology**, and **Historical Geology**, **Palaeontology** and many other fields (e.g., **Ore Prospecting**, **Hydrogeology**, **Environmental Geology** and **Peat Geology**). The aim of **Historical Geology** is to unravel the chronology of geological events, age relations of different geological formations and the evolution of life and climate on Earth. **Physical Sedimentology** is the study of sediments, their characteristics and depositional environments, and geomorphological landforms which they form. This
Geochemistry is the study of the source and fate of chemical species in natural environments, using chemical analysis of minerals, rocks, soils and waters. One of the aims is to describe and quantify the processes that control the recycling of elements and isotopes in nature. The main applications are geochemical exploration, environmental issues, and determining the age and genesis of different rock types. There are several subfields in Geochemistry. In Isotope Geochemistry, radiogenic and stable isotopes are analysed in order to perform age determinations and make inferences on the mechanisms and conditions of rock formations or other research targets. In Environmental Geochemistry, geochemists try to identify natural and anthropological chemical changes in the environment. Geochemical Exploration utilises geochemical properties of the bedrock and its Quaternary cover for discovering new ore deposits.

Geophysics is a natural science that involves the study of the physical structure and physical properties of the Earth and its surrounding space environment, and related physical processes. At the Oulu University, teaching and research in Geophysics are focused on Applied Geophysics, with emphasis on the use of geophysical methods in exploration, mapping and management of natural resources and in environmental and engineering studies. In the life cycle of a mine, Geophysics plays an important role in all stages: before opening the mine in mineral exploration and resource assessment, during active mining operations in exploration for additional resources and environmental monitoring, and after the closure of the mine, in environmental monitoring and mapping of potentially contaminated areas.

Students graduated as geologists from geosciences have been employed by public sector organisations, such as the Geological Survey of Finland, Finland’s environmental administration, ELY Centres (Centres for Economic Development, Transport and the Environment) and universities. In the private sector, significant employers are domestic and foreign exploration companies, mining industry, and companies providing environmental consulting and construction services. The main duties of geologists in these organisations are research and the mapping of bedrock and Quaternary deposits, studying ore deposits, carrying out mineral exploration projects and inventories of sediment and peat resources, groundwater investigations, and various environmental research and administrative tasks.

Students graduated as geophysicists work as researchers in various research institutes such as universities, the Geological Survey of Finland, Finnish Meteorological Institute, Finnish Environmental Institute, and geophysical observatories. Experts of Applied Geophysics are employed by domestic and foreign companies for research and instrumental development related to exploration and exploitation of geological raw materials (groundwater, dimension stones, ore deposits, minerals, oil). Geophysicists also apply their skills in various construction projects and environmental studies to identify potential environmental and anthropogenic hazards.
Major subjects, structure of the degrees and lines of specialisation

In the degree programme of geosciences, it is possible to obtain a lower university degree, Bachelor’s degree (B.Sc.), in Geosciences amounting to 180 credits. After the Bachelor’s degree, students have the possibility to continue to study for a higher university degree, the Master’s degree (M.Sc.), which can be done in three major subjects: Geology and Mineralogy, Quaternary Geology, and Geophysics. The Master’s degree consists of a total of 120 credits of intermediate- and advanced-level studies. The amount of advanced studies in the chosen major subject must be at least 60 credits including the 35 credits of the Master’s thesis. The post-graduate degrees are the Licentiate of Philosophy degree and the Doctor of Philosophy degree, of which the latter can be obtained without the former.

The basic and intermediate level studies of Geophysics can be done in the degree programme of Physics. After completing a BSc degree in Physics with a sufficient amount of courses in Geophysics and Geology, students can apply for transfer to Oulu Mining School for studying Geophysics as their major subject.

Students can graduate from the degree programme of Geosciences via three lines of specialisation:

- Master of Science degree in Geology and Mineralogy with specialisation in Economic Geology
- Master of Science degree in Quaternary Geology
- Master of Science degree in Geophysics with specialisation in Applied Geophysics

It is recommended that the decision on the major subject is made during the second year and not later than during the third year. The choice is not binding, as the line of specialisation can be changed within the degree programme still later through bridging studies. Differing from Geology and Mineralogy and Quaternary Geology, admission to the Geophysics Master’s studies in Oulu Mining School takes place after a Bachelor degree in Physics and a minor subject entity of 25 ECTS credits in Geophysics in the degree programme of Physics have been completed.

In addition to the degree programme described above, Oulu Mining School offers students the International Master’s Programme in Economic Geology. For these students, Geology and Mineralogy is the major subject. All courses in the programme are given in English.

The emphasis of the advanced-level teaching in Geology and Mineralogy is on courses which lead to specialisation in Economic Geology. The goal is that after obtaining a M.Sc. degree, students are sufficiently competent to cope with duties requiring detailed knowledge of the bedrock and its resources. The prime purpose of the education is to meet the need for experts in the growing ore exploration and mining industry. An important aspect of the teaching is to make students familiar with the occurrence, characteristics and genesis of different metallic ore deposits. Other topics include the evolution of the Finnish bedrock, isotope geochemistry,
applied geophysics, ge metallurgy, GIS applications, and geochemistry of mining environment.

The M.Sc. degree programme in **Quaternary Geology** offers the student high level education to understand how exogenic processes operate in different sedimentary environments and what is the human impact on these natural processes today. The core issue in the Quaternary research and education is to understand glacial sedimentology and stratigraphy. This knowledge on the mechanisms that operate in natural sedimentary environments is vital, for example in ore exploration and can also be utilised in many fields ranging from sustainable use of groundwater resources to various environmental issues such as climate change.

In **Applied Geophysics**, teaching and research are focused on using of geophysical methods in exploration and mapping of natural resources and in environmental and engineering studies. The teaching comprises a number of core courses, a selection of specialised courses and a final thesis project. The core courses provide the students with fundamental information about physical backgrounds of basic geophysical techniques and instrumentation essential for practicing applied geophysics. The specialised courses provide more detailed information about geophysical techniques applied at different stages of the mine life circle. They prepare the students for choosing a thesis research area that best suits their interests. The thesis project involves the integration of theory with data derived from geophysical field observations obtained in cooperation with a suitable industrial, governmental or research partner.

Because the candidate-level teaching is given in the degree programme of Physics, course descriptions and requirements are available in the study guide of the degree programme of Physics, whereas the Master’s level studies in Geophysics are described below together with the studies in Geology and Mineralogy, Quaternary Geology and Geochemistry.

**GENERAL ASPECTS OF THE STUDIES**

The education in geosciences is given in the form of lecture courses, practical exercises, seminars, workshops and field courses. The amanuensis of the department will guide students with regard to general questions on the studies in the department and help students to compile a personal study plan (PSP). Students sketch a preliminary PSP in the first autumn during their orientation studies and will design a more precise PSP for the entire study period later on. Persons who help in detailed questions related to each subject are: Eero Hanski in Geology and Mineralogy and Geochemistry, Tiina Eskola in Quaternary Geology, and Kari Moisio in Geophysics.

The geosciences courses are divided into basic studies (code P), intermediate studies (code A) and advanced studies (code S). In addition, language studies and orientation studies (code Y) are part of the curriculum. The geologic education begins with basic studies in geosciences, which are completed during the first academic year. During the first spring semester it is possible to conduct the first compulsory
intermediate-level studies. It is advised to start compulsory minor subject studies for the B.Sc. degree as early as possible, especially a basic chemistry course, which is recommended to be taken during the first autumn semester.

Geology students study for a joint Bachelor's degree in Geosciences, but they can already prepare themselves for the future decision on their line of specialisation by choosing Geology and Mineralogy or Quaternary Geology as one of their minor subjects in their B.Sc. degree. Other minor subjects are also needed to widen students’ possibilities to carry out duties in their future work life. Appropriate minor courses include those given in Chemistry, Information Processing Science, Geophysics, Physics, Mathematics, and technical sciences. The Bachelor level studies described below concern geology students and corresponding studies for future geophysics students are described in the study guide of the degree programme of Physics.

BACHELOR'S DEGREE IN GEO SCIENCES (B.Sc.), 180 ECTS credits

The Bachelor’s degree in geology, which is normally completed within three years, constitutes the following studies:

- General studies, 8 credits
- Basic studies in geology, 36 credits
- Compulsory intermediate studies in geosciences, 48 credits
- Bachelor’s thesis and maturity test, 9 credits
- Optional intermediate courses in Geosciences
- Compulsory minor subject studies
- Optional minor subject studies

GENERAL STUDIES (8 ECTS credits)
770001Y Orientation course for new students, 1 credit 1st autumn
030005Y Information skills, 1 credit 3rd spring

Language studies totalling 6 credits:
902002Y English I, 2 credits 1st spring
902004Y English II, 2 credits 2nd spring
901054Y Swedish, written skills, 1 credit 1st spring
901055Y Swedish, oral skills, 1 credit 1st spring

BASIC STUDIES IN GEOLOGY, 36 ECTS credits

Mineralogy:
771102P Basic course in mineralogy, 6 credits 1st autumn

Geological processes and the structure of the Earth:
771111P Endogenic processes, 6 credits 1st autumn
771112P Exogenic processes, 4 credits 1st autumn
Geotieteiden koulutusohjelma

762104P Introduction to solid earth geophysics, 5 credits 1st autumn

Geology of Finland:
771115P Introduction to bedrock geology of Finland and ore geology, 5 credits 1st spring
771116P Introduction to Quaternary deposits of Finland and their resources, 5 credits 1st spring

Spatial data handling:
762108P GIS and spatial data 1 1st autumn 1st spring

COMPULSORY INTERMEDIATE STUDIES IN GEOLOGY (57 ECTS credits)
772339A Optical mineralogy, 6 credits
773346A Environmental geology, 5 credits
773344A Basics of glacial geology, 5 credits
773317A Physical sedimentology, 5 credits
772385A Ore geology, 5 credits
774301A Basic course in geochemistry, 6 credits
772337A Seminar in geology and mineralogy I, 5 credits, or
773343A Seminar in Quaternary geology, 5 credits
762305A Geophysical research methods of rock and soil, 6 op
771304A Work practice, 4-5 credits
771303A Bachelor’s thesis + 770390A maturity test, 9 credits

OPTIONAL INTERMEDIATE COURSES IN GEO SCIENCES
(Note what is said below about minor subject entities)

OPTIONAL COURSES IN GEOLOGY AND MINERALOGY
772334A Bedrock mapping, 3 credits
772316A Structural geology, 5 credits
772341A Igneous petrology, 7 credits
772344A Sedimentary petrology, 5 credits
772345A Metamorphic petrology, 6 credits
772335A Introduction to ore mineralogy, 5 credits
772310A General mineralogy, 5 credits
772338A Work practice II, 4-5 credits

OPTIONAL COURSES IN QUATERNARY GEOLOGY
773324A Field mapping of Quaternary deposits, 5 credits
773306A Quaternary geology of Finland, 5 credits
773316A Technical properties of sediments, 6 credits
773322A Surficial geology in ore exploration, 5 credits
773300A Quaternary stratigraphy, 5 credits
762306A Hydrology in geosciences

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773345A Work practice II, 4-5 credits

OPTIONAL COURSES GEOCHEMISTRY COURSES
774329A Introduction to environmental geochemistry, 5 credits
774304A Analytical methods in geochemistry, 5 credits

OPTIONAL INTERMEDIATE COURSES IN GEOPHYSICS
See the description of the Physics degree programme

EXAMPLES OF OPTIONAL BASIC-LEVEL COURSES RELATED TO THE MINING TECHNOLOGY AND MINERAL PROCESSING
031010P Calculus I, 5 credits
477011P Introduction to Process and Environmental Engineering I, 5 credits
488010P Introduction to Process and Environmental Engineering II, 5 credits

COMPULSORY MINOR SUBJECT COURSES

The Bachelor’s degree in geology must contain at least one minor subject entity that is compiled from the optional intermediate-level studies in Geology and Mineralogy or Quaternary Geology (see above).

Other compulsory studies for all Bachelor students in geology are:
Chemistry:
A minimum of 5 ECTS credits; course 780117P General and inorganic chemistry recommended

OPTIONAL MINOR SUBJECT COURSES

For complementing the chosen major subject, students can select appropriate optional minor courses from the curriculum of the Oulu Mining School or other faculties, preferably the Faculty of Science and the Faculty of Technology. Most recommendable are courses in Chemistry, Physics, Geophysics, Mathematics, Information Processing Science, Geography and Technology including Process technology, Mineral processing and Mining technology. Minor subject entities are determined by the curriculum of the respective degree programme. It is advised that students strengthen their skills in mathematics at least with the course 031010P Calculus I (5 credits) if any courses in minor subjects require such skills.

A Bachelor of Science degree can include basic- and intermediate-level studies in one minor subject (minimum 60 credits) or basic studies in two minor subjects (2 x 25 credits). It is important to note that if a student wants to choose Geology and Mineralogy as his/her major subject in the Master’s studies, he/she needs to complete a 25-credit entity of optional intermediate-level studies in Geology and Mineralogy, analogously, a 25-credit entity of optional intermediate-level studies in Qua-
ternary Geology, if a student wants to graduate as a Master of Science in Quaternary Geology. Corresponding minor subject entities in Geophysics can be done in the degree programme of Physics.

**BACHELOR’S THESIS (9 ECTS credits)**

The thesis is based on independent research of literature complemented with potential minor field work or laboratory work and is commonly done during the third study year after a sufficient amount of studies have been conducted for the Bachelor’s degree. Before starting the thesis, students must agree upon its details with a supervising professor or lecturer.

**MATURITY TEST**

After completing their Bachelor’s thesis, students write an essay in their native language (Finnish or Swedish) on the topic of the thesis, to show a good command of the language and the topic of the thesis. If the student has got a special permission to use a language that is other than Finnish or Swedish in completing his/her studies, the Dean may allow the student to write the maturity test in the language that he/she used in his/her Bachelor thesis.

**MASTER OF SCIENCE DEGREE (M.Sc.)
(B.Sc. + 120 ECTS credits)**

The degree of Master of Science is a higher university degree and can be obtained by complementing the Bachelor’s degree with additional studies of at least 120 ECTS credits, which include a Master’s thesis worth of 35 ECTS credits and a minimum amount of 25 ECTS credits of advanced courses in the major subject. Minor subject studies should be selected in such a way that they support the major subject studies and the field of specialisation chosen in the Master’s programme.

The major subject in the Master of Science degree is Geology and Mineralogy, Quaternary Geology, or Geophysics. The degrees are the following:

- Master of Science degree in Geology and Mineralogy, specialisation in Economic Geology
- Master of Science degree in Quaternary Geology (Quaternary Geology as the major subject)
- Master of Science degree in Geophysics with specialisation in Applied Geophysics

Irrespective of the line of specialisation, the minimum extent of the required advanced-level studies in the major subject is 60 ECTS credits, which include the 35 ECTS credits of the Master’s thesis. The maturity test has to be done also in the Master’s degree and consists of an abstract of the Master’s thesis written on a separate form.
As mentioned above, students majoring in Geology and Mineralogy are required to have completed at least 25 ECTS credits of optional intermediate-level studies in Geology and Mineralogy. For those students who have been accepted directly to the Master’s programme, these studies need to be performed as bridging studies. Advanced-level studies in Geology and Mineralogy lead automatically to specialisation in Economic Geology. The topic of the Master’s thesis is within the field of Geology and Mineralogy. In addition, it is required that the student has completed at least a total of 10 ECTS credits of studies in Mineral processing and Mining technology.

Students majoring in Quaternary Geology must have completed a minimum of 25 ECTS credits of optional intermediate-level studies in Quaternary Geology. For those students who have been accepted directly to the Master’s programme, these studies need to be performed as bridging studies. The topic of the Master’s thesis must be compatible with the major subject.

Students who major in Geophysics are required completion of a Bachelor of Science degree in Physics and a minimum of 25 ECTS credits of basic- and intermediate level courses in Geophysics (see the description of the Physics degree programme). If not included in the Bachelor’ degree, these Geophysics studies need to be done as bridging studies. The topic of the Master’s thesis must be within the field of Geophysics.

**ADVANCED COURSES IN GEOLOGY AND MINERALOGY**

**Ore geology:**
- 772695S Magmatic ore deposits, 5 credits
- 772692S Hydrothermal ore deposits, 5 credits
- 772693S Sedimentary ore deposits, 5 credits
- 772675S Geophysics in economic geology, 5 credits
- 772675S Applied field techniques in economic geology, 5 credits
- 772632S Regional ore geology of Fennoscandia, 5 credits
- 772687S Gold deposits, 5 credits
- 772628S Layered intrusions and their ore deposits, 5 credits
- 774637S Isotope geochemistry for economic geologists, 6 op
- 772699S Nickel deposits of the Fennoscandian Shield, 5 credits
- 772621S Geology of alkaline rocks, carbonatites and kimberlites, 5 credits
- 772608S Mining geology, 3 credits
- 772667S Seminar in ore geology, 5 credits
- 772694S Geometallurgy and mineral processing, 5 credits
- 772640S Excursion, 5 credits
- 772683S Structural geology for economic geologists, 5 credits

**Regional geology:**
- 772631S Archaean geology, 5 credits
- 772613S Bedrock geology of Finland, 6 credits

**Other advanced-level courses:**
- 772658S Special issues in geology and mineralogy, 1-9 credits
- 762606S GIS and spatial data 2, 3 credits
Geotieteiden koulutusohjelma

772684S GIS applications, 5 credits
772615S Literature essay, 5 credits
773615S Studia generalia lectures, 2 credits
772690S Courses taken at other universities
772666S Master’s thesis, 35 credits

ADVANCED COURSES IN QUATERNARY GEOLOGY

Glacial geology and exploration:
773601S Glacial geology II, 5 credits
773616S Aerial photo interpretation in Quaternary geology, 5 credits (compulsory)
773641S Advanced course of surficial geology in ore exploration I, 5 credits
773642S Advanced course of surficial geology in ore exploration II, 5 credits

Environmental geology:
773627S Global environmental and climate change during the Cenozoic, 5 credits
773673S Field course in environmental geology and geophysics, 3 credits
773650S Biostratigraphy: Pollen course, 5 credits
773654S Biostratigraphy: Diatom course, 5 credits

Sedimentology:
773612S Excursion on regional surficial geology, 3-6 credits
773646S Advanced field techniques, 3 credits
773648S Sedimentary structures, 5 credits
773655S Sedimentology, 5 credits

Other advanced-level courses:
773613S Literature essay, 5 credits
773607S Literature study, 5 credits
773608S Special issues in Quaternary geology, 5 credits
773619S Seminar in Quaternary geology II, 5 credits
773615S Studia Generalia lectures, 2 credits
773679S Courses taken at other universities
773657S Master’s thesis, 35 credits

ADVANCED COURSES IN GEOCHEMISTRY

774636S Geochemistry of mining environment, 5 credits
774637S Isotope geochemistry for economic geologists, 5 credits

ADVANCED COURSES IN GEOPHYSICS

Obligatory courses:
762608S Airborne geophysics, 5 credits
762610S Petrophysics, 5 credits
762609S Modelling and inversion, 5 credits
762615S Borehole geophysics, 5 credits
762612S Gravimetric and magnetic methods, 5 credits
762681S Master’s thesis, 35 credits

Optional courses:
762627S Time-domain electromagnetic research methods, 3 credits
762620S Computers in geophysics, 3 credits
762662S Special courses in geophysics, 1-9 credits
762606S GIS and spatial data 2, 3 credits
772684S GIS applications, 5 credits
762645S Field course in bedrock mapping and applied geophysics, 3 credits
762624S Electrical research methods of rock and soil, 5 credits
762616S Ground penetrating radar sounding, 5 credits
762625S Magnetotellurics, 5 credits
762636S Shallow seismic soundings, 6 credits
762661S Advanced level course from another Finnish university
762663S Advanced level course from another university abroad
762684S Excursion, 2 credits
762630S Modelling of electromagnetic fields, 5 credits
762611S Theory of electromagnetic methods, 5 credits
762617S VLF-method, 5 credits
762646S Field course in environmental geology and applied geophysics, 3 credits

MASTER’S THESIS (35 ECTS credits)

The Master’s thesis is prepared during the last (5th) study year. It is a research assignment with a workload corresponding to 35 ECTS credits. The thesis is based on student’s own field or laboratory studies and, in many cases, these studies are closely related to student’s summer work. Before starting the Master’s project, the subject and other details are agreed with the supervising professor or lecturer.

OTHER STUDIES

300002M Advanced information skills, 1 credit
(recommended to all students working on their Master’s thesis)

POSTGRADUATE STUDIES

Having completed his/her Master of Science degree, a student will be able proceed to pursue the Licentiate of Philosophy degree or the Doctor of Philosophy degree in Geology and Mineralogy, Quaternary Geology or Geophysics, provided that he/she has obtained his/her Master’s degree with good rates (at least 60% of the maximum, 3/5, for both the courses and the Master’s thesis), and his/her research plan has been accepted. The research plan for the Licentiate of Philosophy degree is accepted by the educational board of the geosciences degree programme, while...
that for the Doctor of Philosophy degree is accepted by the University of Oulu Graduate School (UniOGS).

The Licentiate degree consists of the Licentiate thesis (90 credits) and additional advanced- or intermediate-level studies of at least 35 credits, including the Licentiate examination (9 credits). The requirements for the Doctoral degree are the same with the exception that the Licentiate thesis is replaced with the doctoral dissertation. For more information on the doctoral studies, see the website of the Oulu Graduate School (http://www.oulu.fi/tutkijakoulu/).

**POSTGRADUATE COURSES**

Postgraduate courses can contain applicable intermediate- and advanced-level courses in the major subject or other relevant subjects and special courses organised by the UniOGS, of which some are mandatory. In addition, the faculty can grant credits from teaching duties (provided a certain amount pedagogical studies have been passed), participation in scientific meetings and research visits.

771602J Licentiate thesis, 90 credits
771603J Doctoral dissertation
771604J Licentiate examination, 9 credits
771605J Teaching tasks, 1-6 credits
771606J Scientific conferences, 1-7 credits
771607J Research visit, 0.5-2 credits
771608J Research plan and seminar, seminar part, 1 credits (part of 920004J)

Courses organised by the UniOGS:
920004J Research plan and seminar, 4 credits (mandatory)
920001J Introduction to doctoral training, 1 credit (mandatory)
920002J Scientific research and ethics, 2 credits (mandatory)
920003J Information skills for doctoral students, 1 credits
920005J Basics of university pedagogy for doctoral students, 2 credits

**GEOSCIENCES AS A MINOR SUBJECT**

Students of other degree programmes can complete a minor subject entity in geosciences consisting of 15, 25 or 60 ECTS credits. A minor course entity of 15 ECTS credits can also be done in Geology and Mineralogy, Quaternary Geology or Geochemistry. It needs to be noted that the number of participants in some cases (especially in field courses) is limited.

Detailed descriptions of each course can be found in WebOodi (https://weboodi.oulu.fi/oodi/).

**Examinations and grading**
An examination is organised within two weeks after the end of each lecture course according to the course schedule. After that students can participate in two additional examinations for each course. Registration to an examination is regarded as participation. General examination days are arranged once a month as university exams.


Students must register for these examinations using WebOodi latest at 12.00 on the Monday preceding the exam. Summer examinations of the faculty are organised in June and August and the dates are announced separately during the late spring term. Registration for the summer examinations should be done in May.

A numerical scale 0-5 in whole numbers is used in assessing a completed course, with 0 = fail, 1 = sufficient, 2 = satisfactory, 3 = good, 4 = very good and 5 = excellent. In some courses, verbal grading Pass or Fail is applied. For study courses consisting of several subunits, the grade is the weighted average of all subunits. Evaluation of the Master’s thesis is based on the same scale 0-5, and the grade of the thesis is not considered when determining the average grade of the advanced studies.
COURSE DESCRIPTIONS

GENERAL STUDIES

770001Y Orientation course for new students
Orientoivat opinnot
ECTS credits: 1 cr
Language of instruction: Finnish
Timing: 1st year autumn
Learning outcomes: Students are familiar with the university environment and practical issues of their studies and are able find appropriate of advice if needed.
Contents: Students are tutored to the study system of the university and given information on the contents and goals of the degree programme of Geosciences.
Mode of delivery: Face to face
Learning activities and teaching methods: 15 to 18 h of tutoring
Target group: 1st year students
Grading: Pass/fail
Person responsible: N.N.

030005P Information skills
Tiedonhankintakursus
ECTS credits: 1 cr
Language of instruction: Finnish/English
Timing: 2nd year spring
Learning outcomes: Students know the different phases of information retrieval process and basic techniques of scientific information retrieval. They will find the most important reference databases of their discipline and know how to evaluate information sources and retrieval results.
Contents: Retrieval of scientific information, the retrieval process, key databases of the discipline, and evaluation of information retrieval and information sources.
Learning activities and teaching methods: The course involves training sessions (8h), web-based learning materials, exercises in the Optima learning environment and a final assignment on a topic of the student’s own choice.
Target group: 2nd year students
Recommended or required reading
Web-based learning material from Toolbox of Research (https://wiki.oulu.fi/display/tor/1.1+Finding+scientific+information)
Assessment methods: Passing the course requires participation in the training sessions and successful completion of the course assignments.
Grading: Pass/fail
Person responsible: Science and Technology Library Tellus, tellustieto (at) oulu.fi
Other information:

902002Y English I
Englannin kieli I
ECTS credits: 2 cr
Timing: 1st year spring

902004Y English II
Englannin kieli II
ECTS credits: 2 cr
Timing: 2nd year spring

901054Y Swedish, written skills
Ruotsin kieli, kirjallinen taito
ECTS credits: 1 cr
Timing: 1st year spring

901055Y Swedish, oral skills
Ruotsin kieli, suullinen taito
ECTS credits: 1 cr
Timing: 1st year spring

BASIC STUDIES IN GEOSCIENCES

771102P Basic course in mineralogy
Mineralogian peruskurssi
ECTS credits: 6 cr
**305**

**Geotieteiden koulutusohjelma**

**Language of instruction:** Finnish  
**Timing:** 1st year autumn  
**Learning outcomes:** Students obtain a basic knowledge on mineralogy.  
**Contents:** Crystal, crystal systems, mineral, rocks. Formation of minerals in geological processes, chemical and physical properties of minerals, their occurrence and utilisation.  
**Mode of delivery:** Face to face  
**Learning activities and teaching methods:** 20 h lectures, 16 h exercises. Exercises are compulsory.  
**Target group:** 1st year geoscience students  
**Pre-requisites and co-requisites:** No  
**Recommended optional programme components:**  
**Recommended or required reading:** Risto Piispanen and Pekka Tuisku (2005) Mineralogian perusteet.  
[http://cc.oulu.fi/~petuisku/Mineralogia/MinPer.htm](http://cc.oulu.fi/~petuisku/Mineralogia/MinPer.htm)  
**Assessment methods and criteria:** Examination, compulsory exercises  
**Grading:** 5-1/fail  
**Person responsible:** Pekka Tuisku, Jukka Ranta  
**Work placement:** No

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**771113P Introduction to Geology I**  
Geologian peruskurssi I  
**ECTS credits:** 5 cr  
**Language of instruction:** Finnish  
**Timing:** 1st year autumn  
**Learning outcomes:** Students have an understanding of the basic concepts of the Earth, from its composition and internal structure to the geological processes that has led to its evolution the present Earth as part of the solar system. They can tell how endogenic processes in the mantle and crust produce magmas and how magmas produce different igneous rock type upon emplacement below and on the Earth’s surface. Students are able to recognise and classify common igneous rocks based on their mineral composition and are familiar with common metamorphic rocks and know the metamorphic facies concepts. They can relate deformation and metamorphism of the rocks to plate tectonic processes.  
**Contents:** Evolution of the Earth as part of the solar system, structure and composition of the Earth. Classification of igneous rocks, magmatism, origin and crystallisation of magmas, volcanism, metamorphism and formation of metamorphic rocks, plate tectonics and deformation structures.  
**Mode of delivery:** Face to face  
**Learning activities and teaching methods:** 36 h lectures, 6 h exercises  
**Target group:** 1st year geoscience students. The course is a good minor subject course for others.  
**Pre-requisites and co-requisites:** Basic course in mineralogy (771102P) is parallel to this course.  
**Recommended optional programme components:** This course is intended as an introduction to the scope and methods of igneous and metamorphic petrology.  
**Assessment methods and criteria:** Written examination and identification test of rock types.  
**Grading:** 5-1/fail  
**Person responsible:** Eero Hanski  
**Work placement:** No

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**771114P Introduction to Geology II**  
Geologian peruskurssi II  
**ECTS credits:** 5 cr  
**Language of instruction:** Finnish  
**Timing:** 1st year autumn  
**Learning outcomes:** Students have acquired basic knowledge on the concepts and processes of surficial geology. Students should also be able to identify basic sediment types and soils.  
**Contents:** Basic concepts of surficial physical geology, weathering, erosion, sedimentation, and sediment types, soils and geological processes forming sedimentary deposits.  
**Mode of delivery:** Face to face  
**Learning activities and teaching methods:** 16 h lectures, 8 h exercises  
**Target group:** 1st year Geoscience students. The course is a good minor subject course for others.  
**Pre-requisites and co-requisites:** -
Recommended optional programme components: -

Recommended or required reading:

Assessment methods and criteria: Obligatory exercises and written examination
Grading: 5-1/fail
Persons responsible: Juha Pekka Lunkka and Tiina Eskola
Work placement: No

771115P Introduction to bedrock geology of Finland and ore geology
Johdatus Suomen kallioperägeoilta ja maaperäkallioperägeoilta
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 1st year spring
Learning outcomes: Students can describe and recognize the main geological units of the Finnish bedrock and name them based on their stratigraphic position and age relations. They can connect the major geological units to the main stages of the plate tectonic evolution. Students are familiar with most common ore types and industrial minerals occurring in the bedrock and the principal processes leading to their formation and how they are explored.
Contents: Lithostratigraphical units, the Archaean and Palaeoproterozoic bedrock of Finland and younger rock formations. Mineral resources, their classification and origin, exploration methods.
Mode of delivery: face to face
Learning activities and teaching methods: 24 h lectures. In addition, a one-day field trip is organized in May for major subject students.
Target group: Major and minor subject students starting studies in geology.
Pre-requisites and co-requisites: Basic course in mineralogy (771102P), Introduction to Geology I (771113P), Introduction to Geology II (771114P) or equivalent knowledge.
Recommended optional programme components: -

Assessment methods and criteria: Written examination
Grading: 5-1/fail
Persons responsible: Eero Hanski
Work placement: No

771116P Introduction to Quaternary deposits of Finland and their resources
Johdatus Suomen maaperägeoilta ja maaperän raaka-ainevaroihin
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 1st year spring
Learning outcomes: Students can describe the main features and raw material resources of the Finnish Quaternary deposits.
Contents: Main features and raw material resources of the Finnish Quaternary deposits and their origin.
Mode of delivery: Face to face
Learning activities and teaching methods: 22 h lectures. In addition, a one-day field trip is organized in May for major subject students.
Target group: 1st year geoscience students
Pre-requisites and co-requisites: Introduction to Geology II (771114P) or equivalent knowledge.
Recommended optional programme components: -

Assessment methods and criteria: Written examination
Grading: 5-1/fail
Persons responsible: Juha Pekka Lunkka
Work placement: No

762108P GIS and spatial data 1
GIS ja paikkatiedon perusteet 1
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 2nd or 3rd autumn (continues to spring semester)
Learning outcomes: After completion the student collects the basics of spatial data and geographical information systems (GIS) including especially the most important coordinate systems, map projections, Finnish map coordinates and satellite positioning, and knows how to visualise spatial data in various different ways.

Contents: Geoscientific observations and measurements are always tied to spatial location of the data. The course provides basic information about the presentation and handling of spatially dependent geoscientific data and geographic information systems (GIS). The course considers the basics of spatial data, coordinate systems, map projections and map coordinates, satellite positioning, processing and visualisation of spatial data. Computer exercises demonstrate preparation and visualisation of geoscientific data in practice.

Mode of delivery: Face to face

Learning activities and teaching methods:
Lectures and exercises totalling 40 h plus independent study

Target group: Students of Oulu Mining School, and the Faculties of Science and Technology. Obligatory to geosciences students in B.Sc. degree.

Pre-requisites and co-requisites: No specific prerequisites

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.


Assessment methods and criteria: Examination and computer test
Grading: 5-1/fail
Person responsible: Kari Moisio
Work placement: No work practise

762104P Introduction to solid earth geophysics
Johdatus kiinteän maan geofysiikkaan
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 1st year autumn, every year.
Learning outcomes: Upon the completion of the course, a student
- can describe the position and role of geophysics in the field of the Earth system sciences
- can list major unsolved global research problems in the Earth system sciences
- can describe the structure of the Earth and its neighbouring environment in space (spheres), their internal geophysical properties and the interactions between different spheres
- can describe large scale transfer (movement) of rock material inside the Earth and on its surface (convection, plate tectonics)
- can name major geophysical research methods.


Mode of delivery: Face to face

Learning activities and teaching methods:
30 h lectures, 10 h exercises, 93 h independent study

Target group: Course is compulsory for geoscience students (geophysics, geology). Also offered to other students of the University of Oulu.

Pre-requisites and co-requisites: No specific prerequisites. The course substitutes previous courses 762103P Introduction to Geophysics (2 op) and 762192P Solid Earth Geophysics (3 op).

Recommended optional programme components: Parallel courses Introduction to geology I (771113P), Introduction to geology II (771114P)

Geotieteiden koulutusohjelma


Assessment methods and criteria: Examination. B.Sc. students in physics can complete the course 752103P Johdatus geofysikkaan/Introduction to Geophysics (2 cr) in their curriculum by this course without exercises.

Grading: 5-1/fail
Person responsible: Toivo Korja
Other information: https://wiki.oulu.fi/display/762103P/
Work placements: No

COMPULSORY INTERMEDIATE STUDIES IN GEOSCIENCES

772339A Optical mineralogy
Optinen mineralogia
ECTS credits: 6
Language of instruction: Finnish
Timing: 1st spring
Learning outcomes: After the course students are able to identify most common minerals from thin sections under the microscope.
Contents: The basics of crystal optics. Research of the properties of minerals, identifying minerals from thin sections, usage of stereographic projector and basics of the universal stage method.
Mode of delivery: Face to face
Learning activities and teaching methods: 30h lectures, 40 h exercises
Target group: 1st year geoscience students
Pre-requisites and co-requisites: Basic course in mineralogy (771102P)
Recommended optional programme components:
Assessment methods and criteria: Written examination
Grading: 5-1/fail
Person responsible: Pekka Tuisku
Work placement: No

773346A Environmental geology
Ympäristögeologia
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 2nd or 3rd study year
Learning outcomes: Upon completion of the course, students should have acquired basic knowledge of concepts of environmental geology.
Contents: Basic concepts of environmental geology, geological processes, landforms and risks related to geological processes, geological resources, and environmental geological aspects in planning the land use, environmental geochemistry.
Mode of delivery: Face to face
Learning activities and teaching methods: 24 h lectures
Target group: 2nd and 3rd year geoscience students
Pre-requisites and co-requisites: Introduction to Geology II (771114P) or equivalent knowledge
Assessment methods and criteria: Written examination
Grading: 5-1/fail
Person responsible: Juha Pekka Lunkka
Work placement: No

773344A Basics of glacial geology
Glacial geology

**Contents:** The aim of the lecture course is to give geological and physical background of the exogenic processes that operate in terrestrial and marine sedimentary environments. The lecture course also introduces the basic methods and concepts used in physical sedimentology. The topics discussed are related to modern and ancient sedimentary environments and processes including themes such as weathering, soils and palaeosols, mass movement mechanisms, water and ice flow dynamics, erosion and sedimentation processes and products.

**Mode of delivery:** Face to face

**Learning activities and teaching methods:**

26 h lectures

**Target group:** 2nd or 3rd study year geoscience students

**Pre-requisites and co-requisites:** Introductions to Geology II (771114P) or equivalent knowledge, Introduction to Quaternary deposits of Finland and their resources (771116P)

**Recommended optional programme components:**


**Assessment methods and criteria:**

Written examination

Grading: 5-1/fail

**Person responsible:** Juha Pekka Lunkka

**Work placement:** No

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773317A Physical sedimentology

**Fysikaalinen sedimentologia**

**ECTS credits:** 5 cr

**Language of instruction:** Finnish

**Timing:** 2nd or 3rd study year

**Learning outcomes:** Upon completion of the course, students should have acquired basic knowledge of glaciogenic sediment types and of morphological landforms and can present theories of how glaciers are formed.

**Contents:** A review to history of glacial research and its methods; theories of how glaciers are generated and factors that affect them; present-day glaciers and their research; how snow turns into ice; movement of ice; structures of glaciers; glacier types; facts and theories about the geological activities in glaciers and how glacial sediments, landforms and erosional features are formed; glaciofluvial, glaciolacustrine and glaciomarine sedimentation, glacial deposits in pre-pleistocene formations, causes of ice ages.

**Mode of delivery:** Face to face

**Learning activities and teaching methods:**

26 h lectures

**Target group:** 2nd or 3rd study year

**Pre-requisites and co-requisites:** Introductions to Geology II (771114P) or equivalent knowledge, Introduction to Quaternary deposits of Finland and their resources (771116P)

**Recommended optional programme components:**


**Assessment methods and criteria:**

Written examination

Grading: 5-1/fail

**Person responsible:** Juha Pekka Lunkka

**Work placement:** No

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772385A Ore geology

**Malmigeologia**

**ECTS credits:** 5 cr

**Language of instruction:** English

**Timing:** 2nd or 3rd year autumn semester

**Objectives:** Upon completion of the course, students should have a basic knowledge of the classification of ore deposits and an understanding of igneous, hydrothermal and sedimentary ore-forming processes. Students can identify the main types of ores in the field, perform basic mineralogical characterisation of ores, and can formulate a petrogenic model of ore formation.

**Contents:** The ore-forming processes of orthomagmatic, hydrothermal and sedi-
mentary mineral deposits, examples of different ore types, and interpretation of ore forming processes in a plate tectonic context.

Mode of delivery: Face to face

Learning activities and teaching methods: Lectures and hand specimen examination, 30h lectures

Target group: All Bachelor-level geoscience students

Pre-requisites and co-requisites: Basic studies in Geosciences


Assessment methods and criteria: Written examination

Grading: 1-5/fail

Person Responsible: Eero Hanski

Work placement: No

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774301A Basic course in geochemistry
Geokemian peruskurssi
ECTS credits: 6 cr
Language of instruction: Finnish
Timing: 1st spring

Learning outcomes: Upon completion of this course, students will have a broad overview of the different fields of geochemistry and be able to relate the behaviour of elements to different physico-chemical processes in nature. They will be able to convert geochemical data from one form to another (wt%, molar and cation proportions, millequivalents), plot these data on different diagrams, and carry out simple mineral dissolution/precipitation and mass balance calculations.

Contents: Geochemistry as a field of science; history of geochemistry; tasks and fields of geochemistry; origin and electron configuration of chemical elements; origins and structure of the Earth; meteorites; the geochemical classification of the elements; composition of earth's different spheres; geochemical differentiation; composition of magmas; dissolution and precipitation of minerals; pH-Eh-diagrams; introduction to isotope geochemistry.

Mode of delivery: Face to face

Learning activities and teaching methods: 32 h lectures, 12 h exercises

Target group: All students conducting basic courses in geosciences

Pre-requisites and co-requisites: A basic course in chemistry

Recommended optional programme components: It is recommended that a basic course in chemistry (e.g. 780117P) has been taken during the previous fall semester.


Assessment methods and criteria: Examination in both theory and calculations

Grading: 5-1/fail

Person responsible: Eero Hanski

Work placement: No

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772337A Seminar in geology and mineralogy I
Geologian ja mineralogian seminaari I
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 2nd or 3rd study year

Learning outcomes: After the course, students' ability to construct and give a scientific presentation on a subject of their field has increased and their skills to write scientific text have improved.

Contents: Students prepare and give an oral presentation (about 30 minutes) on a subject that has required independent work and judgement. Each participant acts once as an opponent.

Mode of delivery: Face to face

Learning activities and teaching methods: Preparing a seminar presentation and an essay

Target group: All geoscience students (geology and mineralogy)

Pre-requisites and co-requisites: Basic studies in geosciences

Recommended optional programme components: Corresponding seminar is organised for those who give a seminar presentation in Quaternary Geology (773343A). Either 772337A or 773343A is recommended.

Recommended or required reading: Reading material depends on the chosen subjects and is informed upon starting the course/ or students are given the task to search for proper sources from the literature.

Assessment methods and criteria: Semi-
Geotieteiden koulutusohjelma

773343A Seminar in Quaternary Geology I
Maaperägeologian seminaari I
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 2nd or 3rd study year
Learning outcomes: Upon completion of the course, the student will be able to construct an essay on a given scientific topic and give a scientific presentation on a subject of their field
Contents: The student prepares an essay and gives an oral presentation (about 30 minutes) on a subject that has required independent work. The student also acts once as an opponent. Active class participation required.
Mode of delivery: Face to face
Learning activities and teaching methods: Seminar work (oral presentation and acting as an opponent) and independent preparation of an essay.
Target group: Bachelor-level students
Pre-requisites and co-requisites: The required pre-requisite is the completion of the following courses prior to enrolling for the course unit: Basic courses in Geology and Physical Sedimentology (773317A) and Basics of glacial geology (773344A).
Recommended optional programme components: Corresponding seminar is organised for those who give a seminar presentation in Quaternary Geology (772337A). Either 772337A or 773343A is required.
Recommended or required reading: Reading chosen separately for each student.
Assessment methods and criteria: Seminar presentation and acting as an opponent and a short essay
Grading: 5-1/fail
Person responsible: Juha Pekka Lunika
Other information: Topic of the seminar presentation may be related to that of the Bachelor’s thesis.
Work placement: No

762305A Geophysical research methods of rock and soil
Maa- ja kallioperään geofysikaaliset tutkimusmenetelmät
ECTS credits: 6 cr
Language of instruction: Finnish
Timing: 2nd spring
Learning outcomes: After passing the course the student can explain on which the use of geophysical methods in studying rock and soil is based. The student can describe theoretical basics and the measuring techniques of the methods and is able to apply the methods in various important economical and civil tasks.
Contents: The aim of the course is to learn the principles of applying different geophysical methods for various economical and civil tasks. Geophysical subjects in sediments and bedrock and basics for their exploration. Basics of petrophysical properties. Gravity methods, magnetic methods, resistivity methods, IP method, electromagnetic methods, radiometric methods and seismic methods: the physical principles, devices and the most important ways of using them in practice. Aerogeophysical methods. Borehole measurements. Geothermal research.
Mode of delivery: Face to face
Learning activities and teaching methods: Lectures 40 h, practical exercises 20 h, field exercises 20 h plus independent study.
Target group: Students of Oulu Mining School, and the Faculties of Science and Technology. Obligatory to geosciences students in B.Sc. degree.
Pre-requisites and co-requisites: No particular pre-requisites
Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.

Assessment methods and criteria: Examination

Grading: 5-1/fail

Persons responsible: Kari Moisio, Toivo Korja, Elena Kozlovskaya

Work placement: No work practise

771304A Work practice
Harjoitustyö/työharjoitelu

ECTS credits: 4-5 cr

Language of instruction: Finnish/English

Timing: Commonly done as summer work during Bachelor’s studies

Learning outcomes: Students will get familiarity with geologists’ duties in real-world situations and can assess the development of their own expertise during the training.

Contents: Practical training accomplished under the guidance of a qualified geologist in Finland or abroad. Before the training, students must in advance agree upon the details of the field work with their professor, such as the work place, time, instructor and the supervisor.

Mode of delivery: Participation in work life

Learning activities and teaching methods: A period of 1.5 to 3 month of practical work in a company or research institute, written report. For work exceeding 1.5 months 4 ECTS credits are granted and for the extending 2 months, 5 ECTS credits are granted.

Target group: Obligatory to all geoscience students.

Pre-requisites and co-requisites: Required for the test

Recommended optional programme components: A written report on the training work

Grading: Pass/fail

Persons responsible: Eero Hanski, Juha Pekka Lunkka

Other Information: One practical work course belongs to the Bachelor’s degree.

Work placement: Yes

770390A Maturity test
Kypsyysnäyte

ECTS credits: 0 cr

Language of instruction: Finnish or Swedish

Timing: 3rd spring

Learning outcomes: The student can independently produce scientific text using his/her mother tongue. The maturity test shows familiarity with the subjects of the Bachelor’s thesis.

Contents: Written test on the subject of the B.Sc. thesis.

Mode of delivery: Independent preparation for the test

Learning activities and teaching methods: Independent work

Target group: Compulsory in the B.Sc. degree to all geoscience students.

Pre-requisites and co-requisites: Written after the completion of the Master’s thesis.

Recommended optional programme components: No alternative course units

Recommended or required reading: No
Geotieteiden koulutusohjelma

Assessment methods and criteria: A test event. The length of the text is recommended to be one exam paper (four pages).
Grading: Pass/fail

Person responsible: Supervisor of the Master's thesis
Work placement: No work practise

OPTIONAL INTERMEDIATE STUDIES IN GEOLOGY AND MINERALOGY

772334A Bedrock mapping
Kallioperäkartoitus
ECTS credits: 3
Language of instruction: Finnish, in field exercises potentially also English
Timing: 2nd or 3rd study year
Learning outcomes: Upon completion the student should be able to: compile a bedrock map utilise different source materials in this work
Contents: Map materials and coordinate systems, methods of bedrock mapping and geological field work, supervised exercise to produce a bedrock map.
Mode of delivery: Face to face in class and field
Learning activities and teaching methods: 8 h lectures, field exercises and independent assignments 32 h.
Target group: Bachelor-level geoscience students
Pre-requisites and co-requisites: Basic studies in Geosciences
Recommended optional programme components: -

Assessment methods and criteria: Participation in teaching in the field, construction of a geological map and its explanation
Grading: Pass/fail
Person responsible: N.N.
Work placement: No

772341A Igneous petrology
Magmakiiven petrologia
ECTS credits: 7 cr
Language of instruction: Finnish
Timing: 2nd or 3rd year, autumn semester
Learning outcomes: Students will be able to describe and classify the main types of igneous rocks in the field, and identify the main rock forming minerals and the textures of the rocks under the microscope. Students also are able to classify basic petrogenetic processes, including partial melting, crystallisation, and contamination, and will be able to place igneous rocks into a broad geotectonic framework.
Contents: The course provides an introduc-
tion to the main concepts of Igneous Petrology, including nomenclature, classification, processes of melting and crystallisation, and identification of rocks and minerals under the microscope, as well as the distribution of igneous rocks in a global tectonic framework (mid-ocean ridges, subduction zones, continental rifts, oceanic island volcanism, continental anorogenic magmatism). The petrogenesis of the main types of igneous rocks (komatites, basalts, andesites, dacites-rhyolites, granite family, gabbronorites, alkaline rocks) will be discussed.

Mode of delivery: Face to face, independent microscope exercises

Learning activities and teaching methods: 26 h lectures, 30 h microscope exercises

Target group: Bachelor-level geoscience students

Pre-requisites and co-requisites: Optical mineralogy (772339A), Introduction to Geology I (771113P)

Recommended optional programme components: Petrology of metamorphic rocks (772345A) and Petrology of sedimentary rocks (772344A)


Assessment methods and criteria: Learning diary and written report or alternatively written examination

Grading: 5-1/fail

Person responsible: Pekka Tuisku

Work placement: No

772345A Metamorphic petrology

Metamorfisten kiven petrologia

ECTS credits: 6 cr

Language of instruction: Finnish

Timing: 2nd or 3rd study year

Learning outcomes: During the course students will get familiar with the basic concepts of metamorphic rocks and develop a general understanding on their classification and processes of formation. They will know about the major structures of metamorphic rocks and be able to identify their minerals and textures based on macroscopic and microscopic characteristics. In addition, they will be able to relate their mineralogical and textural observations to the processes that generate different kinds of metamorphic rocks.

Contents: Metamorphism and factors that control it; metamorphic facies and their textures and occurrences. Identification of metamorphic rocks and their minerals using microscope.

Mode of delivery: Face to face

Learning activities and teaching methods: 20 h lectures, 20 h microscope exercises.

Target group: 2nd and 3rd year geoscience students

Pre-requisites and co-requisites: Optical mineralogy (772339A), Introduction to Geology II (771114P)


Assessment methods and criteria: Learning diary and written report or alternatively written examination

Grading: 5-1/fail

Person responsible: Pekka Tuisku

Work placement: No

772344A Sedimentary petrology

Sedimenttikivien petrologia

ECTS credits: 5 cr

Language of instruction: Finnish

Timing: 2nd or 3rd study year

Learning outcomes: During the course students will get familiar with the basic concepts of sedimentary rocks and develop a general understanding on their classification and processes of formation. They will know about the major sedimentary structures, major depositional environments and their facies and stratigraphic characteristics and be able to interpret potential sources and transportation mechanisms of sediments based on their macroscopic and microscopic characteristics.

Contents: Characteristics and classification of sedimentary rocks, their mode of occurrence and processes of formation. Identification of sedimentary rocks and their minerals using microscope.

Mode of delivery: Face to face

Learning activities and teaching methods: 26 h lectures, 30 h microscope exercises.

Target group: 2nd or 3rd year geoscience students

Pre-requisites and co-requisites: Optical mineralogy (772339A), Introduction to Geology I (771113P)

Recommended optional programme components: Recommended or required reading: Freeman, 3rd edition.

Assessment methods and criteria: Learning diary and written report or alternatively written examination

Grading: 5-1/fail

Person responsible: Pekka Tuisku

Work placement: No

Language of instruction: Finnish

Timing: 2nd or 3rd study year

Learning outcomes: During the course students will get familiar with the basic concepts of sedimentary rocks and develop a general understanding on their classification and processes of formation. They will know about the major structures of sedimentary rocks and be able to relate their mineralogical and textural observations to the processes that generate different kinds of metamorphic rocks.

Contents: Metamorphism and factors that control it; metamorphic facies and their textures and occurrences. Identification of metamorphic rocks and their minerals using microscope.

Mode of delivery: Face to face

Learning activities and teaching methods: 20 h lectures, 20 h microscope exercises.

Target group: 2nd and 3rd year geoscience students

Pre-requisites and co-requisites: Optical mineralogy (772339A), Introduction to Geology II (771114P)


Assessment methods and criteria: Learning diary and written report or alternatively written examination

Grading: 5-1/fail

Person responsible: Pekka Tuisku

Work placement: No
Target group: 2nd and 3rd year geoscience students

Pre-requisites and co-requisites: Optical mineralogy (772339A), Introduction to geology I (771113P)

Recommended optional programme components:


Assessment methods and criteria: Learning diary and written report or alternatively written examination

Grading: 5-1/fail

Person responsible: Pekka Tuisku

Work placement: No

772335A Introduction to ore mineralogy
Johdatus malmimineralogiaan

ECTS credits: 5 cr

Language of instruction: English

Timing: 2nd or 3rd year

Objectives: Students will obtain basic knowledge on ore minerals and their mode of occurrence, learn to recognise the most common ore minerals and textures under the ore microscope.

Contents: Division and structure of ore minerals, composition and texture, phase diagrams and their applications. Ore microscope and how it is used, microscopic properties of ore minerals. Identification of ore minerals and ore mineral assemblages.

Mode of delivery: Face to face.

Learning activities and teaching methods: 14 h lectures, 21 h exercises.

Target group: Students specializing in geology and mineralogy

Pre-requisites and co-requisites: Introduction to ore geology (771108P), Basic mineralogy (771102P), Optical mineralogy (772339A)

Recommended or required reading:

Assessment methods and criteria: Examination, laboratory exercises

Grading: 1-5/fail

Person Responsible: Eero Hanski

Work placement: No

772310A General mineralogy
Yleinen mineralogia

ECTS credits: 5 cr

Language of instruction: Finnish

Timing: 2nd or 3rd study year

Learning outcomes: The student will deepen their basic knowledge of mineralogy.

Contents: Research history and research methods of mineralogy. Classification of minerals, crystal chemical structures, chemical compositions, the most important properties and occurrence of minerals in rocks.

Mode of delivery: Face to face

Learning activities and teaching methods: 26 h lectures

Target group: 2nd and 3rd year geoscience students

Pre-requisites and co-requisites: Basic course in mineralogy (771106P)

Recommended optional programme components:


Assessment methods and criteria: Written examination

Grading: 5-1/fail

Persons responsible: Pekka Tuisku, Jukka Pekka Ranta, Tiina Eskola

Work placement: No

772338A Work practice II
Työharjoittelu II

ECTS credits: 4-5 cr

Language of instruction: Finnish or English

Timing: Any year after completion of the 1st work practise.

Learning outcomes: Students will get familiar with geologists' duties in real-world situations and can assess the development of their own expertise during the training.
Contents: Practical training accomplished under the guidance of a qualified geologist in Finland or abroad. Before the training, students must in advance agree upon the details of the field work with their professor, such as the work place, time, instructor and the supervisor.

Mode of delivery: Attending work life

Learning activities and teaching methods: A period of 1.5 to 3 month of practical work in a company or research institute, written report. For work exceeding 1.5 months 4 ECTS credits are granted and for the extending 2 months, 5 ECTS credits are granted.

Target group: Bachelor- or Master-level geoscience students

Pre-requisites and co-requisites: -

Recommended optional programme components: -
Recommended or required reading: -
Assessment methods and criteria: A written report on the training work.
Grading: Pass/fail

Person responsible: Eero Hanski

Other information: Only one practical training (773343A or 772337A ) is compulsory to and valid for the Bachelor degree. The second one (772338A) can be included in the Master’s degree.

Work placement: Yes

OPTIONAL INTERMEDIATE STUDIES IN QUATERNARY GEOLOGY

773324A Field mapping of Quaternary deposits
Maaperäkartotuskurssi

ECTS credits: 5 cr

Language of instruction: Finnish

Timing: 2nd or 3rd study year

Learning outcomes: Upon the completion of the course, the student will be able to produce a Quaternary geology map based on own field data.

Contents: A field course introduces the techniques used in mapping of Quaternary deposits. In the field students are reconstructing a 1: 20 000 scale Quaternary map from a pre-selected mapping area.

Mode of delivery: Face to face

Learning activities and teaching methods: 30 h lectures and exercises in the field

Target group: Bachelor-level geoscience students

Pre-requisites and co-requisites: The required pre-requisite is the completion of the following courses prior to enrolling for the course unit: Basic courses in Geosciences, Physical Sedimentology (773317A), Basics of glacial geology (773344A) and Technical Properties of Sediments (773316A).

Recommended optional programme components: -

Assessment methods and criteria: Participation and quality of the map produced during the mapping course

Grading: Pass/fail

Persons responsible: Juha Pekka Lunkka, Tiina Eskola

Work placement: No

773306A Quaternary geology of Finland
Suomen maaperägeologia

ECTS credits: 5 cr

Language of instruction: Finnish

Timing: 2nd or 3rd study year

Learning outcomes: Upon completion of the course, students should have acquired knowledge of the Finnish glacial landforms and deglaciation in Finland.

Contents: The pre-Quaternary landform of Finland; thermomers and cryomers during Pleistocene period; Finnish glacial landforms and their regional division; occurrence of landforms and their combinations as seen in aerial photos; deglaciation; the highest shoreline and its meaning; water-laid deposits; eolian deposits; land uplift; evolutionary phases of lakes; evolution of organic environment.

Mode of delivery: Face to face

Learning activities and teaching methods: 30 h lectures
Target group: 2nd or 3rd study year students

Pre-requisites and co-requisites: Introduction to Geology II (771114P) or equivalent knowledge, Introduction to Quaternary deposits of Finland and their resources (771116P)

Recommended optional programme components:

Assessment methods and criteria: Written examination
Grading: 5-1/fail
Person responsible: Juha Pekka Lunkka
Work placement: No

ECTS credits: 8
Language of instruction: Finnish
Timing: 3rd study year

Learning outcomes: Upon completion of the course, students should have acquired knowledge of specific the physical and geotechnical qualities of sediments.

Contents: Introduction to different boring methods; taking samples of fine-grained sediments. Laboratory work: determining consistency and structure of different sediments; determining different mechanical properties of sediments

Mode of delivery: The tuition will be implemented as face-to-face teaching.

Learning activities and teaching methods: Lectures 30 h, exercises 60 h, independent study 90 h

Target group: The course unit is aimed primarily for students majoring in Quaternary geology

Pre-requisites and co-requisites: Introduction to Geology II (771114P) or equivalent knowledge, Introduction to Quaternary deposits of Finland and their resources (771116P), Quaternary geology of Finland (773306A)

Recommended optional programme components:

Assessment methods and criteria: Students participate actively in teaching, written reports
Grading: 5-1/fail
Person responsible: Tiina Eskola
Work placement: No

ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 2nd or 3rd study year

Learning outcomes: Upon completion of the course, students should have acquired knowledge of the dispersal of ore boulders and how boulders and till geochemistry are utilised in ore exploration.

Contents: This course provides practical skills for performing surficial geological ore prospecting in glaciated areas. Boulder prospecting; glaciogenic and geochemical dispersion in different landforms; different modes of occurrence of element.

Mode of delivery: Face to face

Learning activities and teaching methods: 30 h lectures

Target group: 2nd or 3rd study year students

Pre-requisites and co-requisites: Introduction to Geology II (771114P), Quaternary Geology of Finland (773306A), Basics of glacial geology (773344A)

Recommended optional programme components:

Assessment methods and criteria: Written examination
Grading: 5-1/fail
Person responsible: Juha Pekka Lunkka
Work placement: No

ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 2nd or 3rd study year

Learning outcomes: Upon the comple-
tion of the course, the student will be able to explain the stratigraphical methods used in Quaternary Geology, to discuss stratigraphical issues using basic concepts of stratigraphy. The student will also be able to explain how environments and climate have changed during the Quaternary.

Contents: The last period of the history of Earth is called the Quaternary. The course focuses on Quaternary history and stratigraphy of the Earth. The course consists of the following topics: basic concepts of stratigraphy including litho-, bio-, and chronostratigraphy, geochronology and other types of stratigraphical practices; stratigraphical methods; absolute and relative dating methods; marine and terrestrial sediments as stratigraphical archives; classical and modern stratigraphical models; climate change.

Mode of delivery: Face to face

Learning activities and teaching methods: 26 h lectures

Target group: Geoscience students, geography students (pursuing minor in geology)

Pre-requisites and co-requisites: Introduction to Geology II (771114P) or equivalent knowledge, Introduction to Quaternary deposits of Finland and their resources (771116P)

Recommended optional programme components:


Assessment methods and criteria: Written examination

Grading: 5-1/fail

Person responsible: Juha Pekka Lunkka

Work placement: No

Language of instruction: Finnish (It is possible to do the course in English, although all the lectures and exercises will be given in Finnish).

Timing: 2nd or 3rd spring term; given every year.

Learning outcomes: Upon the completion of the course, a student
- can define the concept of a water cycle, can name the elements of the cycle, can estimate the magnitude of different components using the water balance equation
- can name and distinguish the principles of the methods used to observe evaporation, precipitation and runoff, and summarise their spatial and temporal variation in Finland
- can describe the behaviour of underground water in vadoso zone and aquifers and can define how the groundwater is formed and how it flows
- can identify different types of aquifers and can describe their relationship with structures of soil and bedrock
- owns basics of hydrogeology (groundwater geology)
- can name major geological and geophysical methods used in groundwater research and exploration

Contents: Introduction to hydrology and hydrological processes in geosciences. Properties and behaviour of water in hydrosphere including hydrological cycle, its different components (evaporation, precipitation and runoff) and their relationship, observations and spatial and temporal variation of each hydrological component in Finland. The second part of the course introduces properties and behaviour of water underground including geohydrological and hydrogeophysical aspects of water and hydrogeology. This part of the course concentrates on the behaviour and properties of water in soil, superficial deposits and bedrock, particularly in Finland. Themes such as groundwater flow, aquifers, groundwater quality, geological and geophysical research methods in hydrogeology will also be introduced.

Mode of delivery: Face to face

Learning activities and teaching methods: 40 h lectures, 20 h exercises, 100 h independent study
**Geotieteiden koulutusohjelma**

**Target group:** Course is compulsory for geoscience students (geophysics, geology). Also offered to the other students of the University of Oulu.

**Pre-requisites and co-requisites:** The following courses are required: Introduction to Solid Earth Geophysics (762104P); Physical Sedimentology (773317A); Introduction to Glacial Geology (773303A).

**Recommended optional programme components:** No alternative course units or course units that should be completed simultaneously.


**Assessment methods and criteria:** Examination

**Grading:** 5-1/fail

**Person responsible:** Toivo Korja and Juha Pekka Lunkka

**Work placement:** No work practice

**Other information:** Only one practical training (773343A or 772337A) is compulsory to and valid for the Bachelor degree. The second one (773345A) can be included in the Master’s degree.

**Mode of delivery:** Participation in work life

**Learning activities and teaching methods:** A period of 1.5 to 3 months of practical work in a company or research institute, written report. For work exceeding 1.5 months 4 ECTS credits are granted and for the extending 2 months, 5 ECTS credits are granted.

**Target group:** Bachelor- or Master-level geoscience students

**Pre-requisites and co-requisites:**

**Recommended optional programme components:**

**Recommended or required reading:**

**Assessment methods and criteria:**

**Grading:** Pass/fail

**Persons responsible:** Eero Hanski, Juha Pekka Lunkka

**Other information:** https://wiki.oulu.fi/display/762193P/773343A+Work+practice+II

**ECTS credits:** 4-5 cr

**Language of instruction:** Finnish/English

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**INTERMEDIATE STUDIES IN GEOCHEMISTRY**

**774329A Introduction to environmental geochemistry**

Johdatus ympäristögeokemiaan

**ECTS credits:** 5 cr

**Language of instruction:** Finnish

**Timing:** 2nd or 3rd study year

**Learning outcomes:** The student will acquire knowledge of the physico-chemical processes and factors controlling the dispersion of elements in the surface environments. The will be able to carry out calculations related to hydrogeochemical processes such dissolution/precipitation, solubility of gases, absorption, and metal complex formation.

**Contents:** Concepts of the environment and environmental geochemistry; solution, hy-
dralysis and redox reactions of minerals, sorption and related geochemical processes, topical environmental problems (acid rain, decrease of ozone, greenhouse phenomenon, heavy metal fallout) from the viewpoint of geochemistry; buffer systems of nature; heavy metals in environment; acid mine drainage.

Mode of delivery: Face to face

Learning activities and teaching methods: 30 h lectures, 12 h computer exercises

Target group: 2nd and 3rd year geoscience students

Pre-requisites and co-requisites: Basic course in geochemistry (774301A)

Recommended optional programme components: Advisable to have taken the course before the course Geochemistry of mining environment (774636S).


Assessment methods and criteria: Examination on theory and calculations as homework

Grading: 5-1/fail

Person responsible: Eero Hanski

Work placement: No

774304A Analytical methods in geochemistry

Geokemian analytiikka

ECTS credits: 5 cr

Language of instruction: Finnish

Timing: 2nd or 3rd study year

Learning outcomes: After the course students should know which kind of sample pre-treatment and analysis methods are used for geological samples.

Contents: Detection limits and errors in analysis, presentation of analytical results, sampling, sample pre-treatment, sample digestion (melts, solutions), silicate analysis theories and practice of different instrumental methods (AAS, XRF, ICP-AES, ICP-MS, TIMS), a visit to a geochemical laboratory.

Mode of delivery: Face to face

Learning activities and teaching methods: 24 h lectures, 6 h calculation exercises, visit to a laboratory.

Target group: Bachelor or Master level geoscience students

Pre-requisites and co-requisites: Basic course in geochemistry (774301A)

Recommended optional programme components: -


Assessment methods and criteria: Written examination or essay

Grading: 5-1/fail

Person responsible: Eero Hanski

Work placement: No

INTERMEDIATE STUDIES IN GEOPHYSICS

See the description of the degree programme of Physics

ADVANCED STUDIES IN GEOLOGY AND MINERALOGY

772695S Magmatic ore deposits

Magmaattiset malmit

ECTS credits: 5 cr

Language of instruction: English

Timing: 4th or 5th year

Objectives: After completion of the course students should have knowledge of the occurrence of the most important magmatic ore deposits, including PGE- Ni-Cu, Cr, V-Ti, apatite, and diamond deposits. Students are
familiar with the geology, and can comprehend the petrogenesis of the main Finnish and global magmatic mineral deposits, including the deposits at Kemi (Cr), Portimo and Penikat (PGE), and Kevinia (Ni-Cu-PGE), Mustavaraa (Fe-Ti-V) and Otanniäki (Fe-Ti-V) as well as global deposits including the Bushveld (PGE, Cr, V), Pechenga (Ni), Monchegorsk (PGE), Noril’sk (Ni-Cu-PGE), Sudbury (Ni-Cu-PGE), Kambalda (Ni), Jinchuan (Ni-Cu-PGE) and Panzhihua (Fe-Ti-V). Students will thus have gained an improved capability to contribute to exploration for magmatic ore deposits in Finland.

Contents: Global distribution, geology and petrogenesis of magmatic ore deposits.

Mode of delivery: Face to face

Learning activities and teaching methods: Lectures 30 h, hand-specimen examination, microscopy sessions, exploration modelling

Target group: Masters students and PhD students in geology

Prerequisites and co-requisites: Igneous Petrology (772341A)

Recommended optional programme components: Other courses in the International Master’s course


Assessment methods: Examination

Grading: 5-1/fail

Responsible person: Sheng-Hong Yang

Work placement: No

772693S Sedimentary ore deposits

Sedimentitiset malmit

ECST credits: 5 cr

Language of instruction: English

Timing: 4th or 5th year

Objectives: Students have a knowledge of the distribution of the main hydrothermal ore deposits in Finland, including the Finnish VMS belt, the Kolari Fe-Au skarn deposits, Talivaaara Ni deposit, and Suurikuusikko Au deposit, as well as the most important hydrothermal ore deposits globally, e.g. the porphyry Cu-Mo deposits of the Cordillera, orogenic gold deposits of the Yilgarn craton, Carlin-type gold deposits, MVT deposits.

Contents: Global distribution and petrogenesis of hydrothermal ore deposits.

Mode of delivery: Face to face

Learning activities and teaching methods: Lectures 30 h, hand-specimen examination and microscopy exercises 6 h

Target group: Master’s students and PhD students in geology

Prerequisites and co-requisites: Igneous Petrology (772341A), Metamorphic petrology (772345A)

Recommended optional programme components: Other courses in the International Master programme


Assessment methods and criteria: Examination

Grading: 5-1/fail

Responsible person: N.N.

Work placement: No
Recommended optional programme components: Other courses in the International Master programme

Recommended or required reading:

Assessment methods and criteria: Examination
Grading: 5-1/fail
Responsible person: N.N.

Work placement: No

772675S Geophysics in economic geology
Geofysiikka malmigeologiassa
ECTS credits: 5 cr
Language of instruction: English
Timing: 4th or 5th year

Learning activities and teaching methods:
Lectures 30 h, data interpretation exercises 30 h
Target group: Master's students and PhD students in geology
Prerequisites and co-requisites: Bachelor's degree and Ore geology (772385A)
Recommended or required reading:
Assessment methods and criteria: Examination
Grading: 5-1/fail
Person responsible: Elena Kozlovskaya

772682S Applied field techniques in economic geology
Näytteenotto, kairaus, analyysi, malminet-sintägeokemia, maaperägeologia malminetsinnässä
ECST credits: 5 cr
Language of instruction: English
Timing: 4th or 5th year

Objectives: Students will be able to describe and classify the different dispersion processes of the chemical elements in different environments. They are able to choose the most appropriate sampling and analysis methods to carry out an exploration program.

Contents: The course includes the basic principles of exploration geochemistry and the use of surficial deposits in ore exploration. The dispersion mechanisms of elements in different environments are described. The use of the fine fraction and heavy minerals of surficial deposits will be included in the course contents. It also provides an introduction to the sampling in the field using different drilling techniques and discusses the main analysis techniques.

Mode of delivery: Face to face

Learning activities and teaching methods:
Lectures 30 h, exercises 30 h
Target group: Masters students and PhD students in geology
Prerequisites and co-requisites: Bachelor's degree and Ore geology (772385A)
Recommended or required reading:
Assessment methods and criteria: Examination
Grading: 5-1/fail
Responsible person: N.N.

Work placement: No

772632S Regional ore geology of Fennoscandia
Fennoskandian alueellinen malmigeologia
ECTS credits: 5 cr
Language of instruction: English
Timing: 4th or 5th year

Learning outcome: After the course, students should have an understanding of the occurrence and petrogenesis of the most important ore deposits in Fennoscandia, and their main analogues in a global context. Students will thus have gained an improved capability to contribute to mineral exploration in Finland.

Contents: Factors that control temporal and spatial distribution of ores, with particular focus on Finnish and Fennoscandian ore deposits, including the Finnish VMS (Pyhäjärvi, Outokumpu), chromite (Kemi), PGE (Portimo, Penikat, Kontijärvi), vanadium (Mustavaara, Kottelainen), Fe (Kolari district, Otaniemäki), gold (Suurikuusikko, Pahtavaara, Pampalo), and Ni deposits (Kevitsa, Talivaara, Vammala-Kotalahti belt), the Swedish Kiruna and Skellefteå districts, the Pechenga deposit of Russia, and the Norwegian Fe-Ti deposits.

Mode of delivery: Face to face

Learning activities and teaching methods: Lectures 30 h, hand-specimen examination

Target group: Masters students and PhD students in geology

Prerequisites and co-requisites: Ore geology (772385A), Ore mineralogy (772335A).


Assessment methods and criteria: Examination

Grading: 5-1/fail

Person responsible: N.N.

Work placement: No

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772687S Gold deposits

Kultamalmit

ECTS credits: 5 cr

Language of instruction: English

Timing: 4th or 5th year

Learning outcomes: The students know the distribution of the major gold deposits in Finland and elsewhere, they comprehend the main models of ore formation, and they can formulate criteria relevant in exploration for the various types of gold deposits.

Contents: Distribution and petrogenesis of gold deposits globally.

Mode of delivery: Face to face

Learning activities and teaching methods: Lectures 30 h, microscopy exercises

Target group: Masters students and PhD students in geology

Prerequisites and co-requisites: Ore geology (772385A), Ore mineralogy (772335A).


Assessment methods and criteria: Examination

Grading: 5-1/fail

Person responsible: N.N.

Work placement: No

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772628S Layered intrusions and their ore deposits

Kerrosmalmit ja niiden malmit

ECTS credits: 5 cr

Language of instruction: English

Timing: 4th or 5th year

Learning outcome: By the end of this course, students should have an understanding of the origin of igneous layering, the processes that control the generation and emplacement of the magmas, and the formation of the ore deposits associated with layered intrusions. Students will be able to compare layered igneous bodies to the world’s main layered intrusions (notably Bushveld Complex, Great Dyke, Stillwater Complex, Skaergaard Monchegorsk, and Panzhuhua) in terms of stratigraphy, petrogenesis and mineralisation potential. In particular, students will be able to assess the economic potential of Finnish layered intrusions.

Contents: Layered intrusions in space and time, mineralogy, petrology, stratigraphy and ore-forming processes in layered intrusions. Examination of rock textures and mineralogy under the microscope and exploration modelling.

Mode of delivery: Face to face
Learning activities and teaching methods:
30 h lectures, 12 h exercises
Target group: Masters students and PhD students in geology
Prerequisites and co-requisites: Igneous petrology, Ore geology.
Assessment methods and criteria: Examination
Grading: 5-1/fail
Person responsible: Sheng-Hong Yang
Work placement: No

772689S Nickel deposits of the Fennoscandian Shield
Fennoskandian kilven nikkelimalmit
ECTS credits: 5 cr
Language of instruction: English
Timing: 4th or 5th year
Learning outcome: Upon completion of the course, students should know the geology, petrogenesis, and geophysical signatures of the major Ni deposits in Finland and Fennoscandia. Major deposits covered include the Finnish Ni belt, Kevitsa, Pechenga, Monchegorsk, Outokumpu, and Talvivaara. Students will be able to compare the Fennoscandian deposits to Ni deposits elsewhere in the world, and to compile key targeting criteria for exploration.
Contents: Geology and petrogenesis of Ni deposits of the Fennoscandian Shield.
Mode of delivery: Face to face
Learning activities and teaching methods: Lectures 30 h, 12 h microscopy exercises 12 h
Target group: Master’s and PhD students in geology
Prerequisites and co-requisites: Igneous petrology (772341A), Ore geology (772385A).
 Assessment methods and criteria: Examination
Grading: 5-1/fail
Person responsible: Hugh O’Brien
Work placement: No


772621S Geology of alkaline rocks, carbonatites and kimberlites
Alkalikivien, karbonatiittien ja kimberliittien geologia
ECTS credits: 4 cr
Language of instruction: English
Timing: 4th or 5th year
Learning outcome: Upon completion of the course, students are familiar with the occurrence, composition and genesis of alkaline rocks, carbonatites and kimberlites and can assess their economic potential.
Contents: Occurrence of alkaline rocks, carbonatites and kimberlites, and their mineralogy, petrography, geochemistry, petrogenesis and economic geology.
Mode of delivery: Face to face
Learning activities and teaching methods: 24 h lectures
Target group: Master’s and PhD students in geology
Prerequisites and co-requisites: Igneous petrology (772341A), Ore geology (772385A).
Recommended optional programme contents: Other module in the International Master programme
Assessment methods and criteria: Examination
Grading: 5-1/fail
Person responsible: Hugh O’Brien
Work placement: No

772608S Mining geology
Kaivosgeologian kursi
ECTS credits: 3 cr
Language of instruction: English
Timing: 4th or 5th year
Learning outcome: Students learn practical aspects of the work of mining geologists.
Contents: Lectures on various aspects of mining, underground and surface visits to mining operations and processing plant, exercises including logging and GIS applications. The course will be arranged with an industry partner. Previous partners include Pyhäasalmi Cu-Zn Mine and Suunkuusikko gold mine.
Mode of delivery: Face to face on a mine site.

Learning activities and teaching methods:
40 h lectures, mine visits and exercises.
Target group: Master students in geology
Prerequisites and co-requisites: Hydrothermal ore deposits, Magmatic Ore Deposits, Petrology of selected ore deposits.
Recommended optional programme components: Other courses in the international master programme.
Recommended or required reading: Will be given on site.
Assessment methods and criteria: Report
Grading: Pass/fail
Person responsible: Eero Hanski
Work placement: No

772667S Seminar in ore geology Malmigeologian seminaari
ECTS credits: 5 cr
Language of instruction: English
Timing: 4th or 5th year
Learning outcome: The course will enhance students' ability to construct and deliver a scientific presentation and deepen their knowledge on different ore types. Students will be able to summarise the geology and petrogenesis of selected ore deposits and present these data to a specialist audience.
Contents: Students write a 20-page paper on a subject in the field of ore geology. The paper is presented in a seminar meeting with someone acting as an opponent. Each student acts as an opponent to a paper in their turn.
Mode of delivery: Face to face

Geometallurgia ja mineraalien rikastus
ECTS credits: 5 cr
Language of instruction: English
Timing: 4th or 5th year
Learning outcome: Students learn practical aspects of the work of mining geologists. Students will be equipped to perform the basic tasks of mining geology.
Contents: Lectures on various aspects of mining, underground and surface visits to mining operations and processing plant, exercises including logging and GIS applications. The course will be arranged with an industry partner. Previous partners include Pyhäasalmi Cu-Zn Mine and Suunkuusikko gold mine.
Mode of delivery: Face to face on a mine site.

Learning activities and teaching methods:
Independent literature studies, oral presentations by students, seminars c. 20 h
Target group: Masters and Phd students
Prerequisites or required reading: Bachelor's degree.
Assessment methods and criteria: Oral presentation and acting as an opponent
Grading: Pass/fail
Person responsible: Eero Hanski
Work placement: No

772694S Geometallurgy and mineral processing
Geometallurgia ja mineraalien rikastus
ECTS credits: 5 cr
Language of instruction: English
Timing: 4th or 5th year
Learning outcome: Upon completion of the course students should be able to: 1) Describe the principles of different areas of geometallurgy (ore geology, process mineralogy, minerals processing, modeling and simulation) and how they are linked in a geometallurgical concept. 2) Use different research and analytical methods of importance for geometallurgy and interpret the results. 3) Evaluate, analyse and interpret the geometallurgical data in a quantitative way. 4) Design a geometallurgical sampling, analysis and research campaign. 5) Design a geometallurgical program.
Contents: The course will give an introduction to main parts of the geometallurgy: 1) ore geology, 2) geostatistics, 3) process mineralogy, 4) minerals processing and 5) modelling and simulation. The main focus is put in process mineralogy, mineral processing and in assimilating the geometallurgical concept. Exercises, assignments and seminars concentrate on practical aspects of geometallurgy needed in mining industry.
Mode of delivery: Face to face

Learning activities and teaching methods:
Lectures and PC classes with assignments (attending a serious game) 15 h, laboratory work 10 h, seminars 8 h.
Target group: geology majors
Prerequisites and co-requisites: Ore geology (772385A), Ore microscopy (772335A).

Recommended or required reading:

Assessment methods and criteria: Laboratory classes, participation of the game, geometallurgical investigations (for the seminar) and the seminars are compulsory. Laboratory reports, seminars, the investigation and the opposition are each awarded points based on the attained level. Assignments and reports must be delivered in time or there will be an automatic deduction of points. The total points production determines the grand grade of the course, and it is given on the scale Fail-1-5.

* For grade 1, the student must be able to describe different parts and procedures of geometallurgy, and to conduct a routine geometallurgical analysis.
* For grade 2, the student must be able to collect geometallurgical data and perform an analysis with interpretation.
* For grade 3 the student must be able to evaluate and interpret geometallurgical data provided by different analytical and research techniques and to report the results.
* For grade 4, the student must be able to design geometallurgical campaign, interpret the result and establish a geometallurgical program.
* For grade 5, the student must be able to apply the acquired skills to a new geometallurgical case, interpret, report and present the results and to defend the conclusions.

Grading: 5-1/fail
Person responsible: Pertti Lamberg
Work placement: No

772640S Excursion

ECTS credits: 5 or 6
Language of instruction: English
Timing: 4th or 5th year

Learning outcome: The objective is to widen the student’s field experience. Through exposure to novel geologic environments, students will have learnt to appreciate the diversity of geologic processes and environments on Earth.

Contents: Introduction to Finnish or foreign geological field targets. Excursions typically last 1-2 weeks and consist of visits to field outcrops, as well as discussion of exposed structures and rocks. Past excursions went to Finland, Spain, South Africa, and Norway and Iceland.

Mode of delivery: Face to face in field or mine

Learning activities and teaching methods: Pre-exursion seminar, field techniques, excursion

Target group: Master students and PhD students in geology

Recommended optional programme components: Other courses in the International Master programme

Recommended or required reading: other

Mode of delivery: Face to face in field or mine

Assessment methods and criteria: Pre-exursion seminar, field protocol

Grading: pass/fail

Person responsible: N.N.

Work placement: No

772683S Structural geology for economic geologists

Rakennegeologiia malmigeologille

ECTS credits: 5 or 6

Language of instruction: English

Timing: 4th or 5th year

Learning outcome: Upon completion the course, students should be able to carry out structural geological observation, to identify and describe different structural elements. In addition, they are able to use needed statistical methods and analyse structural data. They can exploit computer-aided methods in structural interpretation and are able to perform structural interpretation based on given source data.

Contents: Methods of geometrical analysis, structural geological data and data management, projections and diagrams, practical strain analysis, fold shape analysis, petrographic identification of pervasive structural elements, regional fold and fault systems, structural geological maps and structural interpretation.

Mode of delivery: Face to face teaching in classroom and field

Learning activities and teaching methods: Lectures 8 h, field exercises 32 h, exercises
40 h and writing a report in Finnish or English

**Target group:** Master students in geology and mineralogy

**Prerequisites and co-requisites:** Structural geology (772316A), Digital modelling and geological information systems in geosciences (771302A) or corresponding knowledge and intermediate studies for the Bachelor’s degree.

**Recommended or required reading:**

**Assessment methods and criteria:** Report

**Grading:** 5-1/fail

**Responsible person:** N.N.

**Work placement:** No

### 772631S Archean geology

**Arkeeisen kallioperän geologia**

**ECTS credits:** 5 cr

**Timing:** 4th or 5th year

**Learning outcome:** Students will have gathered a thorough understanding of the geology and mineral deposits of Archean terranes in Fennoscandia and are able to draw comparisons to Archean terranes elsewhere in the world. Students understand the origins of life on the planet, and implications on geological processes.

**Contents:** Evolution of the Earth’s early crust, associated mineralisation processes, and emergence of life. Particular focus is placed on Fennoscandia, Kaapvaal, Yilgarn, Pilbara, Superior, and Greenland.

**Mode of delivery:** Face to face

**Learning activities and teaching methods:** 30 h lectures, given by staff of Oulu University and selected invited speakers.

**Target group:** Master’s and PhD students in Geosciences

**Recommended or required reading:**
- Additional material delivered during the course.

**Assessment methods and criteria:** Examination/essay

**Grading:** 5-1/fail

**Responsible person:** Eero Hanski

**Language of instruction:** English

**Work placement:** No

### 772684S GIS applications

**GIS-sovellutukset**

**ECTS credits:** 5 cr

**Timing:** 4th or 5th Spring

**Learning outcomes:** After the course, students can utilise the possibilities of the geographic information system in geological research and specific methods of spatial data analyses.

**Contents:** Spatial data analyses as a component of the geographical information system (GIS).
Mode of delivery: Face-to-face teaching and exercises.
Learning activities and teaching methods: 8 h lectures and demonstrations and 32 h exercises
Target group: Master's student in geology and mineralogy
Prerequisites and co-requisites: Studies equivalent to Bachelor's degree, Basics of GIS
Recommended or required reading: Will be informed separately
Assessment methods and criteria: Computer test
Grading: Pass/fail
Person responsible: Elena Kozlovskaya
Work placement: No

762606S GIS and spatial data 2
GIS ja paikatiedon perusteet 2
ECTS credits: 3 cr
Language of instruction: Finnish (optional-English)
Timing: 3rd to 5th study year
Learning outcomes: After this course student can use GIS-software, he can identify, apply and modify different types of spatial data and analyse them with spatial analysis tools. He can also create understandable and clear visual presentations.
Contents: In this course student familiarises to GIS-software and the possibilities they offer in presenting and analysing spatial data in practical exercises.
Mode of delivery: Face to face
Learning activities and teaching methods: Exercises and exercises totalling 50 h, self-study 50 h. The course is passed by returning exercise report.
Target group: Students of Oulu Mining School, and the Faculties of Science and Technology
Pre-requisites and co-requisites: Course GIS and spatial data 1 or equivalent knowledge is recommended before participation.
Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.
Recommended or required reading: Exercise material
Assessment methods and criteria: In this course assessment is based on the evaluation of the written reports of exercises.
Grading: 5-1/fail
Person responsible: Kari Molsio
Work placement: No work practise

772658S Special issues in geology and mineralogy
Geologian ja mineralogian erityiskysymyksiä
ECTS credits: 1-3 cr
Language of instruction: English
Timing: 4th or 5th year
Learning outcome: The objective of the course is to provide the students with knowledge on the current developments in a special topic in geology and mineralogy.
Contents: The students will have gained a deeper understanding of specific aspects of the subject.
Mode of delivery: Face to face
Learning activities and teaching methods: Teaching can include lectures and laboratory exercises (incl. hand-specimen examination, microscopy exercises and modelling). Amount of hours will be informed separately.
Target group: Master’s and PhD students in geology
Prerequisites and co-requisites: Bachelor’s degree
Recommended or required reading: Assessment methods and criteria: Examination
Grading: 5-1/fail
Person responsible: Eero Hanski
Work placement: No

772615S Literature study
Kirjallisuustutkielma
ECTS credits: 5 cr
Language of instruction: English
Timing: 4th or 5th year
Learning outcome: Students acquire deep knowledge on a particular geology and mineralogy topic.
Contents: Independent literature search and writing of an essay on a given theme.
Mode of delivery: Independent work and personal tuition
Target group: Master’s students
Prerequisites and co-requisites: Bachelor’s degree
Recommended or required reading: Will be informed separately
Assessment methods and criteria: Report
Grading: pass/fail
Person responsible: Eero Hanski
Work placement: No

773615S Studia Generalia lectures
Studia Generalia -esitelmät
ECTS credits: 2 cr
Language of instruction: Finnish or English
Timing: 4th or 5th study year
Learning outcomes: Students will acquire information on the current duties and special fields of geologists working in different sectors of the society and they will learn to gather the most essential points from lectures.
Contents: Students attend lectures given by external visitors having different types of careers as geologists.
Mode of delivery: Face to face
Learning activities and teaching methods: Attendance of at least four lectures
Target group: All intermediate- and advanced-level geoscience students
Pre-requisites and co-requisites:
Recommended optional programme components:
Recommended or required reading: Material presented during lectures
Assessment methods and criteria: circa 2-page reports on each lecture
Grading: Pass/fail
Person responsible: N.N.
Work placement: No

772690S Studies in other universities and colleges
Muissa yliopistoissa ja korkeakouluissa suoritetut kurssit
ECTS credits: course dependent
Contents: Courses taken in international exchange programs (Erasmus, Nordplus) or courses taken in other Finnish universities.
Person responsible: Professors

772666S Master’s thesis
Pro gradu -tutkielma
ECTS credits: 35
Language of instruction: Finnish, English
Timing: 5th year
Learning outcomes: Upon completing a Master’s thesis, students will gain advanced understanding on a subject belonging economic geology or geology and mineralogy in generally. They will be able to use and apply pertinent research methods and theoretical knowledge of their research field, make independent inferences from their observations and measurements, and utilise effectively scientific literature.
Mode of delivery: Students carry out a personal research project, which is normally based field and/or laboratory work, and they write a Master’s thesis (pro gradu) on the results. The topic of the thesis is agreed with the supervisor from the department and with other potential internal or external supervisors. Personal guidance is given by the supervisor(s) during the research and writing stage. The official reviewers of the thesis are decided by the chair of the degree programme board of the faculty after the proposal of the professor of the discipline and the thesis is accepted and rated by the degree programme board or the responsible person of the degree programme.
Target group: All Master’s level geoscience students
Pre-requisites and co-requisites: Sufficient amount of intermediate- and advanced-level courses to enable the student to start independent research work.
Recommended optional programme components:
Recommended or required reading: Reading is decided separately in each case
Assessment methods and criteria: Thesis
Grading: 5-1/fail
Person responsible: Professors and lecturers
Work placement: Commonly yes

770690S Maturity test
Kypsyysnäyte
ECTS credits: 0 cr
Language of instruction: Finnish or English
Timing: 5th year
Learning outcomes: The student can write an informative abstract on his/her M.Sc. thesis, showing that he is familiar with the topic of his/her thesis.
Contents: The student describes and analyses the material, research methods, and results of his/her M.Sc. thesis.
Mode of delivery: Independent work
Learning activities and teaching methods: Independent work
Target group: Compulsory to all M.Sc. stu-
dents in geosciences

**Pre-requisites and co-requisites:** Written after the completion of the Master’s thesis.

**Recommended optional programme components:** No alternative course units

**Recommended or required reading:** No special reading (material of the M.Sc. thesis)

**Assessment methods and criteria:** One-page abstract, which is written on a special form provided by the faculty.

**Grading:** Pass/fail

**Person responsible:** Supervisor of the Master’s thesis

**Work placement:** No work practise

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**ADVANCED STUDIES IN QUATERNARY GEOLOGY**

**773601S Glacial geology II**

Gläsiariegologia II

**ECTS credits:** 5 cr

**Language of instruction:** Finnish

**Timing:** 4th or 5th study year

**Learning outcomes:** Upon completion of the course the student will be able to explain the physical properties of glaciers and the genesis of glacial sediments and glacial landforms.

**Contents:** Dynamics and hydrology of glaciers; erosion and sedimentation processes in glacial environment; basics of glaciology; subglacial, englacial and supraglacial processes. Origin of different glacigenic sediments and landforms and modelling of paleoice sheets.

**Mode of delivery:** Face to face

**Learning activities and teaching methods:** 26 h lectures

**Target group:** Geology students

**Pre-requisites and co-requisites:** Bachelor of Science degree

**Recommended optional programme components:**

**Recommended or required reading:**


**Assessment methods and criteria:** Written examination

**Grading:** 5-1/fail

**Person responsible:** Juha Pekka Lunkka

**Work placement:** No

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**773616S Aerial photo interpretation in surficial geology**

Maaperägeologisen ilmakuvatulkintaa

**ECTS credits:** 5 cr

**Language of instruction:** Finnish

**Timing:** 4th or 5th study year

**Learning outcomes:** Upon completion of the course, students should be able to identify and interpret basic landforms from air photographs.

**Contents:** Basics of air photograph interpretation; identification of landforms from air photographs and topographical maps; mapping based on air photograph interpretation and the necessary field research. Students compile a map of a small area.

**Mode of delivery:** Face to face

**Learning activities and teaching methods:** 20 h lectures, 30 h exercises

**Target group:** Master’s level geoscience students

**Pre-requisites and co-requisites:** Quaternary geology of Finland (773306A), Basics of glacial geology (773344A)

**Recommended optional programme components:**

**Assessment methods and criteria:** Pre-examination, exercises and written examination

**Grading:** 5-1/fail

**Person responsible:** Juha Pekka Lunkka and Tiina Eskola

**Other information:** Obligatory in Master of Science degree in Quaternary geology

**Work placement:** No

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**773641S Advanced course of surficial geology in ore exploration I**

Maaperägeologisen malminetsinnän jatkokuurssi I

**ECTS credits:** 5 cr

**Language of instruction:** Finnish

**Timing:** 4th or 5th study year

**Learning outcomes:** Upon completion of the course, students have gained knowledge of the mode of occurrence of elements in surficial deposits, research methods of heavy minerals and their use in ore exploration.

**Contents:** Mode of occurrence of elements in surficial deposits; research methods of occurrence of elements; using partial extrac-
Geotieteiden koulutusohjelma

773627S Global environmental and climate change during the Cenozoic
Globaalit ympäristömuutokset kenotsoin aikana
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 4th or 5th study year
Learning outcomes: Upon completion of the course the student will be able to explain the mechanisms behind the natural climate and environmental change and relate that to the ongoing changes in climate and environment.
Contents: Mechanisms and rates of environmental and climate change during the past 100 million. The course introduces, for example the influence of orbital cycles, tectonics, ocean currents and ice sheets on the environmental and climate change during the deep past.
Mode of delivery: Face to face.
Learning activities and teaching methods: 24 h lectures
Target group: Advanced-level geology students
Pre-requisites and co-requisites: No
Recommended optional programme components: No
Assessment methods and criteria: Attending lectures and written examination.
Grading: 5-1/fail
Person responsible: Juha Pekka Lunkka
Work placement: No

773650S Biostratigraphy: pollen and spores
Biostratigrafia: siitepölyt
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 4th, 5th year
Learning outcomes: Upon completion of the course, students should be able to prepare pollen samples in the laboratory and identify the most common pollen types and spores in Finland.
Contents: Theory of the pollen analysis and laboratory methods, the most common pollen...
and spore types, manufacturing preparations, sediment analysis.

Mode of delivery: Face to face

Learning activities and teaching methods:
- Lectures 20 h
- Exercises 38 h
- Independent work 40 h

Target group: The course unit is aimed primarily at major subject students

Pre-requisites and co-requisites: Introduction to Geology II (771114P)

Recommended optional programme components: -

Recommended or required reading:

Assessment methods and criteria: Students participate actively in teaching, written report
Grading: Pass/fail
Person responsible: Tiina Eskola
Work placement: No
773612S Excursion on regional surficial geology
Alueellisen maaperägeologian retkeily
ECTS credits: 3-6 cr
Language of instruction: Finnish
Timing: 4th or 5th study year
Learning outcomes: After the course students are able to recognise Quaternary deposits that are typical for different areas.
Contents: Several-day excursion in Finland or abroad, during students will be introduced to Quaternary deposits and stratigraphic type sections in different areas.
Mode of delivery: Face to face in the field
Learning activities and teaching methods: Excursion
Target group: Quaternary geology students
Pre-requisites and co-requisites: Introduction to Geology II (771114P), Quaternary geology of Finland (773306A), Basics of glacial geology (773344A)
Recommended optional programme components: -
Recommended or required reading: Selected separately for each excursion
Assessment methods and criteria: Written report
Grading: Pass/fail
Person responsible: Juha Pekka Lunkka
Work placement: No

773646S Advanced field techniques
Kenttätutkimuksen erikoiskurssi
ECTS credits: 3 cr
Language of instruction: Finnish
Timing: 4th or 5th study year
Learning outcomes: Upon completion of the course the student will be able to use a range of field techniques required in Quaternary Geology research projects (e.g. aerial image, sedimentological, drilling, ground penetrating techniques).
Contents: Field course comprises planning and implementation of geological methods to collect geological data (sedimentological, geomorphological and geophysical data) from a preselected field area.
Mode of delivery: Face to face in class and field
Learning activities and teaching methods: Field course, 40 teaching and exercise in the field.
Target group: Advanced-level geology students
Pre-requisites and co-requisites: Bachelor of Science degree
Recommended optional programme components: -
Recommended or required reading: Recommended or required reading: Assessment methods and criteria: Participation in the field course
Grading: Pass/fail
Person responsible: Juha Pekka Lunkka
Work placement: No

773648S Sedimentary structures
Sedimenttirakenteet
ECTS credits: 5 cr
Language of instruction: Finnish (optionally English)
Timing: 4th or 5th study year
Learning outcomes: Upon completion of the course, the student is able to identify various sedimentary structures and facies associations and use them for palaeoenvironmental reconstructions.
Contents: The course introduces the sedimentary structures, the physical background of their genesis and the occurrence of these structures in different sedimentary environments. The course also includes exercises to identify different sedimentary structures.
Mode of delivery: Face to face
Learning activities and teaching methods: 24 h lectures and 15 h exercises
Target group: Advanced-level geology students
Pre-requisites and co-requisites: Bachelor of Science degree
Recommended optional programme components: -
Assessment methods and criteria: Examination.
Grading: 5-1/fail
Person responsible: Juha Pekka Lunkka
Work placement: No

773655S Sedimentology
Sedimentologia

ECTS credits: 5 cr

Language of instruction: Finnish (optionally English)

Timing: 4th or 5th study year

Learning outcomes: Upon completion of the course, the student will be able to explain how different sediment beds and sediment associations are related to different sedimentary environments. The student will also be able to link individual observations to various sedimentary processes and their products and explain the fundamental concepts used in sequence stratigraphy.

Contents: The topics that are introduced in the course are: sedimentary environments, their processes and products, basin analysis and sequence stratigraphy.

Mode of delivery: Face to face

Learning activities and teaching methods: 30 h lectures

Target group: Advanced-level geology students

Pre-requisites and co-requisites: Bachelor of Science degree

Recommended optional programme components:


Assessment methods and criteria: Examination

Grading: 5-1/fail

Person responsible: Juha Pekka Lunkka

Work placement: No

773607S Literature study

Kirjallisuustutkielma

ECTS credits: 5 cr

Language of instruction: Finnish

Timing: 4th or 5th study year

Learning outcomes: Students can search for relevant literature on a given topic and write an essay with proper reference procedure.

Contents: Student searches literature on the given topic and writes an essay.

Mode of delivery: Independent work

Learning activities and teaching methods: Essay writing

Target group: Advanced-level students in Quaternary geology

Pre-requisites and co-requisites: Introduction to geology II (771114P), Quaternary geology of Finland (773306A), Basics of glacial geology (773344A)

Recommended optional programme components: -

Recommended or required reading: Will be informed separately

Assessment methods and criteria: Essay

Grading: Pass/fail

Person responsible: Juha Pekka Lunkka

Work placement: No

773613S Literature essay

Kirjallisuusaine

ECTS credits: 5 cr

Language of instruction: Finnish

Timing: 4th or 5th study year

Learning outcomes: Students can search for relevant literature on a given topic and write an essay with proper reference procedure.

Contents: Student searches literature on the given topic and writes an essay.

Mode of delivery: Independent work

Learning activities and teaching methods: Essay writing

Target group: Master's level geoscience students

Pre-requisites and co-requisites: Introduction to geology II (771114P), Quaternary geology of Finland (773306A), Basics of glacial geology (773344A)

Recommended optional programme components: -

Recommended or required reading: Will be informed separately

Assessment methods and criteria: Essay

Grading: Pass/fail

Person responsible: Juha Pekka Lunkka

Work placement: No

773608S Special questions in Quaternary geology

Maaperägeologian erityiskysymyksiä

ECTS credits: 5 cr

Language of instruction: Finnish

Timing: 4th or 5th study year

Learning outcomes: Upon completion of the course, the student will be able to critically assess and analyse recent research results of the chosen topic lectured.
Contents: Guest lecture course on recent advances in Quaternary Geology.

Mode of delivery: Face to face

Learning activities and teaching methods: 30 h lectures

Target group: Master’s level Quaternary geology students

Pre-requisites and co-requisites: Bachelor of Science degree

Recommended optional programme components: -

Recommended or required reading: Announced separately.

Assessment methods and criteria: Attending lectures and written examination

Grading: 5-1/fail

Person responsible: Juha Pekka Lunkka

Work placement: No

773619S Seminar in Quaternary geology II

Maaperägeologian seminaari II

ECTS credits: 5 cr

Language of instruction: Finnish

Timing: 2nd or 3rd study year

Learning outcomes: The objective is to enhance students’ ability to construct and give a scientific presentation on a subject of their field.

Contents: Students prepare and give an oral presentation (about 30 minutes) on a subject that has required independent work and judgement. Each participant acts once as an opponent. Active class participation required.

Mode of delivery: Face to face

Learning activities and teaching methods: Seminar

Target group: Master’s students in Quaternary geology

Pre-requisites and co-requisites: Introduction to Geology II (771114P), Quaternary geology of Finland (773306A), Basics of glacial geology (773344A)

Recommended optional programme components: -

Recommended or required reading: Will be informed separately

Assessment methods and criteria: Oral presentation, acting as an opponent and an essay

Grading: Pass/fail

Person responsible: Juha Pekka Lunkka

Work placement: No

773615S Studia Generalia lectures

Studia Generalia -esitelmät

See above.

773679S Courses taken at other universities

Muissa yliopistoissa ja korkeakouluiissa suoritut kurssit

ECTS credits: dependent on the course

Learning outcomes: dependent on the course

Contents: Courses taken in international exchange programmes (Erasmus, Nordplus) or courses taken in other Finnish universities.

Person responsible: Professors

773657S Master’s thesis

Pro gradu -tutkielma

ECTS credits: 35 cr

Language of instruction: Finnish/English

Timing: 5th study year

Learning outcomes: Upon completing their Master’s thesis, students will gain advanced understanding on a subject belonging to two of the four specialisations: Quaternary geology and geoenvironment. They will be able to use and apply pertinent research methods and theoretical knowledge of their research field, make independent inferences from their observations and measurements, and utilise effectively scientific literature.

Contents: Independent research and literature study and production of scientific text

Mode of delivery: Personal supervision.

Learning activities and teaching methods: Students carry out a personal research project, which is normally based field and/or laboratory work, and they write a Master’s thesis (pro gradu) on the results. The topic of the thesis is agreed with the supervisor from the department and with other potential internal or external supervisors. Personal guidance is given by the supervisor(s) during the research and writing stage.

Target group: Advanced-level geology students

Pre-requisites and co-requisites: A sufficient amount of intermediate- and advanced-level courses has to be done to enable the student to start independent research work.

Recommended or required reading: Is decided separately in each case

Assessment methods and criteria: Thesis
**Grading:** 5-1/fail  
**Person responsible:** Professors and lecturers  
**Work placement:** Yes (commonly)

**770690S Maturity test**  
**Kypsyynäyte**  
**ECTS credits:** 0 cr  
**Language of instruction:** Finnish or English  
**Timing:** 5th year  
**Learning outcomes:** The student can write an informative abstract on his/her M.Sc. thesis, showing that he is familiar with the topic of his/her thesis.  
**Contents:** The student describes and analyses the material, research methods, and results of his/her M.Sc. thesis.  
**Mode of delivery:** Independent work  
**Learning activities and teaching methods:**

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**ADVANCED STUDIES IN GEOCHEMISTRY**

**774636S Geochemistry of mining environment**  
**Kaivosympäristön geokemia**  
**ECTS credits:** 5 cr  
**Language of instruction:** English  
**Timing:** 4th or 5th year  
**Objectives:** After completing the course, students can describe and assess environmental problems associated with metal mining. They are familiar with the chemical and mineralogical phenomena related to acid mine drainage and know how to test the acid-producing or -neutralizing capacity of rock types.  
**Contents:** Oxidation of sulphidic ores, formation of secondary minerals, water chemistry in mining environment, acid neutralisation capacity of rocks waste and its determination, factors involved in acid mining drainage (AMD) and its mitigation.  
**Mode of delivery:** Face to face  
**Learning activities and teaching methods:** 28 h lectures  
**Target group:** Master’s students in geology and mineralogy and other students interested in environmental issues.  
**Prerequisites and co-requisites:** Basic course in geochemistry (774301A), also recommended Introduction to Environmental Geochemistry (774329A)  
**Recommended optional programme components:** -  
**Assessment methods and criteria:** Written exam/essay  
**Grading:** 5-1/fail  
**Responsible person:** Eero Hanski  
**Work placement:** No work practise

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**774637S Isotope geochemistry for economic geologists**  
**Isotooppigeokemiaa malmigeologeille**  
**ECTS credits:** 6 cr  
**Language of instruction:** English  
**Timing:** 4th or 5th year  
**Objectives:** After completing the course, students can interpret and assess geological literature where isotopes have been utilised. They are able to calculate the ages of rocks using given isotope measurements of different isotopic systems and based on isotopic
rations, can make inferences on the origin of different rock types including ore deposits.

**Contents:** Mechanisms of radioactive disintegration; mass spectrometry; different radiogenic and stable isotope systems (e.g., Rb-Sr, Sm-Nd, Re-Os, Lu-Hf, Sm-Nd and U-Pb and Pb-Pb; S and C isotopes); examples of the use of isotopes in the research of ore deposits.

**Mode of delivery:** Face to face

**Learning activities and teaching methods:** 32 h lectures, 16 h computer exercises

**Target group:** Master’s students in geology and mineralogy

**Prerequisites and co-requisites:** Ore geology (772385A)

**Recommended optional programme components:**


**Assessment methods and criteria:** Examination on theory + essay and calculations as homework

**Grading:** 5-1/fail

**Responsible person:** Eero Hanski

**Work placement:** No

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**ADVANCED STUDIES IN GEOPHYSICS**

**762608S Airborne geophysics**

**Lentogeofysiikka**

**ECTS credits:** 5 cr

**Language of instruction:** Finnish (optionally English)

**Timing:** 2nd or 3rd spring term

**Learning outcomes:** After completion the student identifies the special characteristics of airborne geophysical measurements, and knows how to process and interpret airborne geophysical data in various different ways.

**Contents:** The course provides basic knowledge on airborne geophysical investigation methods. The course focuses on the airborne geophysical mapping made by the Geological Survey of Finland. The course considers the theoretical principles of the magnetic, electromagnetic and radiometric measurements, practical measurement arrangements, auxiliary measurements, navigation and positioning, data processing and interpretation and the special characteristics of magnetic and electromagnetic anomalies. Modelling and interpretation software are used in computer exercises to emphasise the lectures.

**Mode of delivery:** Face to face

**Learning activities and teaching methods:** Lectures and demonstrations 30 h, independent study 100 h

**Target group:** Primarily for the students of the degree programme in Oulu Mining School. Compulsory for geophysics students in M.Sc studies.

**Pre-requisites and co-requisites:** No specific prerequisites
Recommended optional programme
components: No alternative course units or
course units that should be completed simul-
taneously.
Recommended or required reading: Lecture
notes and Peltoniemi, M. (1998) AERO-
geoysikaaliset menetelmät.
Assessment methods and criteria: Exam-
ination
Grading: 5-1/fail
Person responsible: Toivo Korja
Work placement: No work practice
Other information: https://wiki.oulu.fi/display/762332A/

762627S Time-domain electromagnetic
research methods
Aika-alueen sähkömagneettiset tutkimusmen-
etelmät
ECTS credits: 3 cr
Language of instruction: English (or Finn-
ish depending on participants)
Timing: 4th or 5th study year
Learning outcomes: After completion the
student identifies the special characteristics
of time-domain electromagnetic methods,
recognises the anomalies of various geo-
logical targets and knows how to make mea-
surements and interpret data using computer
software based on layered earth model.
Contents: The course gives detailed infor-
mation about time-domain electromagnetic
(TEM) methods. Unlike in frequency-domain
methods, where time-harmonic current are
used, an electromagnetic pulse is generated
by an abrupt change of direct current in a
wire loop in TEM. The course considers the
physical background, various measurement
systems, response for various earth models,
processing and interpretation methods for
TEM methods. The course includes comput-
er exercises, field work and data interpreta-
tion.
Mode of delivery: Face to face
Learning activities and teaching methods:
30 h lectures and demonstrations, self-study
50 h
Target group: Primarily for MSc students of
geophysics. Also for the other students of the
University of Oulu.
Pre-requisites and co-requisites: No spe-
cific prerequisites
Recommended optional programme
components: No alternative course units or

762620S Computers in Geophysics
Geofysiikan ATK
ECTS credits: 3 cr
Language of instruction: Finnish
Timing: 4th or 5th study year
Learning outcomes: After completion the
student can make a computer program that
does file I/O and data handling and numeri-
cal computations related to geophysics.
Contents: The solution of geophysical prob-
lems often requires writing own computer
programs. The course applies Fortran pro-
gramming language to solve some geophy-
sical problems and tasks such as reading
from file, formatted writing, numerical compu-
tations and data visualisation. The course
consists of practical computer exercises and
compulsory tasks related to them.
Mode of delivery: Face to face
Learning activities and teaching methods:
30 h exercises, approved tasks, self-study 50 h
Target group: Primarily for the students of
the degree programme in geosciences and
physics. Also for the other students of the
University of Oulu.
Pre-requisites and co-requisites Prior
knowledge on computer programming (e.g.
763114P, 763315A or 763616S)
Recommended optional programme
components: No alternative course units or
course units that should be completed simul-
taneously.
Recommended or required reading: Exer-
cise material and Haataja J., Rahola J. &
Ruokolainen J. (1998) Fortran 90/95 and
Press W.H., Flannery B.P., Teukolsky S.A &
Fortran.
Assessment methods and criteria: Participation and approved project work
Grading: Pass/fail
Person responsible: N.N.
Work placement: No work practise

762662S Geofysiikan erikoisluennot
Special courses in geophysics
ECTS credits: 1-9 cr
Language of instruction: Usually English
Contents: Credit points according to the course. Lectures given by visiting scientists. Contents and assessment will be negotiated with the professor in advance. These courses are usually held in English and they will cover topical issues of current geophysical research.
Learning activities and teaching methods: According to the course.
Target group: Optional for students of geophysics.
Recommended or required reading: According to the course.
Assessment methods and criteria: Pass/fail
Person responsible: N.N.

762606S GIS and spatial data 2
GIS ja paikkatiedon perusteet 2
ECTS credits: 3 cr
Language of instruction: Finnish (optionally English)
Timing: 3rd to 5th study year
Learning outcomes: After this course student can use GIS-software, he can identify, apply and modify different types of spatial data and analyse them with spatial analysis tools. He can also create understandable and clear visual presentations.
Contents: In this course student familiarises to GIS-software and the possibilities they offer in presenting and analysing spatial data in practical exercises.
Mode of delivery: Face to face
Learning activities and teaching methods: Exercises and exercises totalling 50 h, self-study 50 h. The course is passed by returning exercise report.
Target group: Students of Oulu Mining School, and the Faculties of Science and Technology.
Pre-requisites and co-requisites: Course GIS and spatial data 1 or equivalent knowledge is recommended before participation.
Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.
Recommended or required reading: Exercise material
Grading: 5-1/fail
Person responsible: Kari Moisio
Work placement: No work practise

762645S Field course in bedrock mapping and applied geophysics
Kallioperägeologian ja geofysiikan maakurssi
ECTS credits: 3 cr
Language of instruction: Finnish
Timing: 4th or 5th study year
Learning outcomes: After completion the student know how to make field measurements related to geological mapping and know better the requirements of data processing, interpretation, and reporting.
Contents: The course introduces the students of geophysics with geological bedrock mapping and gives the students of geology practical information about the methods of applied geophysics. The geophysical methods include magnetic, electrical, electromagnetic profiling. The course starts with four days of field work, after which the student groups process and interpret the collected geological and geophysical data themselves and report their results.
Mode of delivery: Face to face
Learning activities and teaching methods: 32 h field work, 20 h processing and interpretation of measured data, approved written report, 28 h self-study
Target group: Compulsory in MSc studies of geophysics.
Pre-requisites and co-requisites: Geophysical research methods of rock and soil 762305A (earlier 762302A or 762102P).
Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.
Geotieteiden koulutusohjelma

Assessment methods and criteria: Participation and approved written report
Grading: Pass/fail
Person responsible: N.N.
Work placement: No work practice

762679S Maturity test
Kypsyysnäytte
ECTS credits: 0 cr
Language of instruction: Finnish or English
Timing: 5th study year
Learning outcomes: The student can independently produce text from the research field of his/her thesis using the language of the thesis (762681S).
Contents: If a student has written a maturity test for his/her Bachelor degree, showing a good command of Finnish or Swedish, the maturity test for the M.Sc. degree is an abstract of his/her Master’s thesis, written as regulated by the faculty.
Mode of delivery: Face to face
Learning activities and teaching methods: Independent work
Target group: Compulsory for Master of Science in geophysics.
Pre-requisites and co-requisites: Written after the completion of the Master’s thesis.
Recommended optional programme components: No alternative course units
Recommended or required reading: No reading
Assessment methods and criteria: A test event
Grading: Pass/fail
Person responsible: N.N.
Work placement: No work practise

762624S Electrical research methods of rock and soil
Maa- ja kallioperän sähköiset tutkimukset
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 3rd - 5th year
Learning outcomes: After passing the course the student can explain the theoretical basics and use of electric methods based on the DC theory, can use in practice the measuring instruments of different electric methods and is able to analyse and interpret measured data in near-surface geophysical surveys.
Mode of delivery: Face to face
Learning activities and teaching methods: Lectures 30 h, an independent exercise (field measurement and its interpretation), self-study 103 h
Target group: Optional for M.Sc. students of geophysics
Pre-requisites and co-requisites: Geophysical research methods of rock and soil 762305A (earlier 762302A or 762102P)
Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.
Assessment methods and criteria: One written examination and accepted report of an independent exercise
Grading: 5-1/fail
Person responsible: N.N.
Work placement: No work practise

762616S Ground penetrating radar sounding
Maatutkaluotaus
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 4th or 5th study year
Learning outcomes: After completion the student identifies the special characteristics of GPR soundings and can process and interpret GPR data using modern computer software.

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Contents: Ground penetrating radar (GPR) is a high frequency (20-2000 MHz) electromagnetic research instrument that is widely used in surficial and environmental geology and geotechnical and geophysical investigations. The course provides students with the basic knowledge and skills on GPR as a geophysical investigation method. The course deals with theoretical background, practical measurement arrangements, data processing, presentation and analysis. The course includes exercises, where basic mathematics and data processing are introduced, and a compulsory practical work, where the students process and interpret GPR data from their own measurements.

Mode of delivery: Face to face

Learning activities and teaching methods:
Lectures 20 h and 20 h demonstrations and practical work, self-study 93

Target group: MSc students of geophysics, students of surficial and environmental geology, and students of water resources and environmental engineering. Also for the other students of the University of Oulu.

Pre-requisites and co-requisites: No specific prerequisites

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.

Recommended or required reading: Lecture notes, selected articles from geophysical journals and Jol, H.M (Ed.) (2009) Ground penetrating radar theory and applications.

Assessment methods and criteria: Exam and approved report
Grading: 5-1/fail

Person responsible: Kari Moisio

Work placement: No work practise

76262SS Magnetotellurics
Magnetotelluriikka

ECTS credits: 5 cr

Language of instruction: English (or Finnish depending on participants and lecturer)

Timing: 4th or 5th year

Learning outcomes: Upon the completion of the course, a student
- can explain the bases of magnetotelluric methods
- is able to plan and carry out magnetotelluric survey
- is able to use numerical tools for the time series processing and the analysis of the magnetotelluric impedance tensor, modelling and inversion
- can use geophysical, petrophysical and geological data in the tectono-geological interpretation of the conductivity models
- can describe the major targets of the applications of the magnetotelluric method and list the major research groups

Contents: The magnetotelluric method is one of a few geophysical methods suited to investigate crustal and upper mantle structure. Recently, due to methodological and instrumental improvements, the magnetotelluric method is coming common in the studies of near-surface targets. In these cases, the method is usually called a radiomagnetotelluric and audiomagnetotelluric method. The Course deals with the theoretical background of magnetotelluric method. Survey design. Instruments. Time series processing. Impedance tensor and its internal properties. Distortions. Inversion in 1D-, 2D- and 3D-environment. Electrical anisotropy. Visualisation of data and results. Conductivity mechanisms. Interpretation of conductivity models. Examples.

Mode of delivery: Face to face

Learning activities and teaching methods:
Lectures and computer exercises 40 h, homework exercise coevally with lectures; includes field measurements, self-study 93 h

Target group: Recommended for the students interested in lithospheric research as well as applied work. Also for other students of the University of Oulu.

Pre-requisites and co-requisites: It is recommend that the lectures of the courses “Theory of electromagnetic methods” (762611S) and “Modelling of electromagnetic fields” (762630S) have been attended.

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.


Assessment methods and criteria Exam nation (form to be selected during the course) and the completion of the report on homework exercise.
Grading: 5-1/fail

Person responsible: Toivo Korja
Work placement: No work practise
Other information: https://wiki.oulu.fi/display/762625S/

762636S Shallow seismic soundings
Matalaseismiset luotaukset
ECTS credits: 6 cr
Language of instruction: Finnish (optionally English)
Timing: 4th or 5th study year
Learning outcomes: After this course student knows how to apply and use seismic methods to investigate soil and bedrock structure. Student can explain theoretical background, limitations and error sources of the seismic methods. Student knows how use seismic equipment in the field, measure seismic data, interpret and analyse measured data and he can also create a summary of the measurement.
Contents: This course gives basic knowledge required for seismic refraction-, reflection soundings and surface wave studies and their interpretation. Contents of the course: Physical principles and theory of the seismic soundings, interpretation, seismic tomography, mining seismology and seismic monitoring, processing and measurement in practice. Case histories. Independent work includes refraction or reflection seismic sounding in the field.
Mode of delivery: Face to face
Learning activities and teaching methods: Lectures 30 h, exercises 15 h, an independent exercise, self-study 115 h
Target group: Optional for students of Geophysics. Recommend for everyone interested in shallow seismic soundings especially for groundwater investigations.
Pre-requisites and co-requisites: No specific prerequisites
Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.

Assessment methods and criteria: One written examination and accepted report of an independent exercise
Grading: 5-1/fail
Person responsible: Kari Moisio
Work placement: No work practise

762661S An advanced level course from another Finnish university
Muissa yliopistoissa ja korkeakouluissa kotimaassa suoritetut kurssit
ECTS credits: Variable credits
Contents: Courses taken at other Finnish universities.
Assessment methods and criteria: -
Person responsible: N.N.

762663S An advanced level course from another university abroad
Muissa yliopistoissa ja korkeakouluissa ulkomailla suoritetut kurssit
ECTS credits: dependent of the course
Contents: Courses taken in international exchange programs (Erasmus, Nordplus), for example, in universities abroad.
Assessment methods and criteria: Dependent of the course
Person responsible: Professors and lecturers

762681S M.Sc. work (thesis and seminar)
Opinnäyte (pro gradu-tutkielma ja esitelmä)
ECTS credits: 35 cr
Language of instruction: Finnish or English
Timing: 5th study year
Learning outcomes: The student can define and describe the background and methods for the research field of his/her thesis, and is able to perform relatively large research project as well as to handle reporting of the results. Finally the student can give a seminar talk based on his/her thesis.
Contents: The student must demonstrate ability to scientific thinking, to define a research problem, choose the research methods and be able to use to methods to solve the problem. In addition the student must show adequate familiarity with the literature related to the subject of thesis and skills in scientific writing. The subject must be chosen with the professor of geophysics.
Mode of delivery: Face to face
Learning activities and teaching methods:
Writing a thesis, giving a seminar talk, and participating in the seminars during one term. Self-study 93 h.

Target group: Compulsory for students of geophysics in the M.Sc. degree.

Prerequisites and co-requisites: No specific prerequisites.

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.

Recommended or required reading: The list of stops is delivered to students prior to excursion. Based on the list, students collect information on the stops in advance as well as collect the material delivered in stops.

Assessment methods and criteria: Participation in the excursion and the completion of a written report/poster prepared together by all participants.

Grading: Pass/fail

Person responsible: Toivo Korja

Work placement: No work practice.

Other information: Travel costs and major part of accommodation costs are covered by the section of geophysics. Participants cover other costs (e.g. meals).

https://wiki.oulu.fi/display/762684S/

762684S Excursion
Opintoretki
ECTS credits: 2 cr
Language of instruction: Finnish
Timing: 2nd to 5th year. Arranged on demand.

Learning outcomes: After the excursion, a student can list some of the employers in the field of geosciences and the work done there. After the excursion, the student can list the role of geophysicist in companies and other organisations and analyse the skills and knowledge needed to successfully complete the work of a geophysicist. After the excursion, the student can create a generalised profile of a geophysicist working in a company or in other organisation.

Contents: The students at their final stage of studies make a guided excursion and visit companies and research institutions applying geophysical techniques.

Mode of delivery: Face to face

Learning activities and teaching methods:
Two to three days long excursion arranged by teachers. After the excursion participants write a common report or prepare a poster. Participation in the excursion and completion of the report.

Target group: M.Sc. students in geophysics.

Prerequisites and co-requisites: No specific prerequisites.

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.

762612S Gravimetric and magnetic methods
Painovoima- ja magneettiset menetelmät
ECTS credits: 5 cr
Language of instruction: Finnish or English

Timing: 4th or 5th year

Learning outcomes: After completion the student identifies the special characteristics of geophysical gravimetric and magnetic methods, recognises anomalies of various kinds, and knows how to apply data processing and interpretation methods to example data.

Contents: Because the variations of density and magnetisation create changes in Earth’s gravity and magnetic field, the measurements of these fields can be used in geological bedrock mapping and mineral exploration. The course provides knowledge about the geophysical gravity and magnetic field measurements including physical and theoretical background, instrumentation, practical measurement arrangement, data processing and principles of interpretation. Modelling and interpretation software are used in computer exercises to study the generation of gravity and magnetic anomalies of various kinds.

Mode of delivery: Face to face

Learning activities and teaching methods:
Lectures 20 h and 20 h demonstrations and practical work, self-study 93 h.
Target group: MSc students of geophysics. Also for the other students of the University of Oulu.

Pre-requisites and co-requisites: No specific prerequisites.

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.

Recommended or required reading: Lecture notes, selected articles from geophysical journals and Blakely, R.J. (1995) Potential theory on gravity and magnetic applications.

Assessment methods and criteria: Exam and approved report

Grading: 5-1/fail

Person responsible: Elena Kozlovskaya

Work placement: No work practice

762610S Physical properties of rocks
Petrofyysikka
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 4. or 5. year for students in geophysics.

Learning outcomes: Upon the completion of the course, a student-
- can define the position, role and significance of petrophysics (rock property analysis) in geophysical and geological research
- can explain the physical properties of major rocks and rock forming minerals and their mutual dependence
- can describe how the temperature and pressure affect the physical properties of rocks
- can relate the structure of the rocks with the physical properties of the rocks
- can use petrophysical data in the geological interpretation of geophysical models
- is able to measure the major petrophysical properties of rock samples

Contents: Physical properties of rocks and minerals including density, magnetic, elastic, electric, thermal and radiometric properties, their mutual dependence and behaviour as a function of temperature and pressure. In practical exercises the students will e.g. carry out rock property analysis for a given set of samples using the facilities at the faculty.

Mode of delivery: Face to face

Learning activities and teaching methods: Lectures 30 h, exercises 14 h, homework exercise, self-study 116 h

Target group: Compulsory for M.Sc. students in geophysics and recommended for those who work with the geological interpretation of geophysical models.

Pre-requisites and co-requisites: It is recommended that the course Geophysical research methods of rock and soil (762305A) has been attended. Courses of basics of geology (mineralogy, petrology) are also essential.

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.


Assessment methods and criteria: Examination (form to be selected during the course) and completion of the report on homework exercise.

Grading: 5-1/fail

Person responsible: Toivo Korja

Work placement: No work practice

Other information: https://wiki.oulu.fi/display/762607S/

762630S Modelling of electromagnetic fields
Sähök&magneettisten kenttien mallintaminen
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 4th or 5th study year

Learning outcomes: After passing the course the student can justify and explain how to find out theoretical electromagnetic responses of the earth model either by electromagnetic scale modelling or by analytical solution or by numerical modelling. The student can use different numerical methods and is able to apply them in solving electromagnetic field equations.

Contents: To familiarise students with methods in getting the theoretical anomalies for one- or multidimensional earth structures. Electromagnetic fields: field equations, boundary conditions. Layered model. Multi-dimensional model: physical modelling, inte-
The course covers the theoretical basics of the most common electromagnetic methods and their characteristics. The student learns how to interpret data visually and computationally.

Contents: Electromagnetic (EM) measurements are used to provide information about the subsurface variations of electrical conductivity that can be used in geological mapping of soil and bedrock, environmental studies and mineral exploration. The course provides knowledge on the theory and applications of the geophysical EM methods including electromagnetic induction, quasi-optical, transmission surface analogy, finite-difference method, finite-element method. Thin sheet approximation. Solving the set of linear equations. On the errors.

Mode of delivery: Face to face

Learning activities and teaching methods:
- Lectures 30 h, demonstrations 10 h, an independent work, self-study 93 h

Target group: Optional for students of geophysics in the M.Sc. degree

Pre-requisites and co-requisites: No specific prerequisites

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.

Recommended or required reading:
- Assessment methods and criteria: A final examination and an independent exercise work
- Grading: 5-1/fail
- Person responsible: N.N.
- Work placement: No work practise

762611S Theory of electromagnetic methods
Sähkömagneettisten mittausten teoria
ECTS credits: 5 cr
Language of instruction: English (or Finnish depending on participants and lecturer)
Timing: 4th or 5th study year
Learning outcomes: After completion the student knows how to link electromagnetic theory with its many applications, identifies the basic characteristics of the most common geophysical electromagnetic methods and the anomalies of various geological targets and knows how to interpret data visually and computationally.

Contents: Electromagnetic (EM) measurements are used to provide information about the subsurface variations of electrical conductivity that can be used in geological mapping of soil and bedrock, environmental studies and mineral exploration. The course provides knowledge on the theory and applications of the geophysical EM methods including electromagnetic induction, quasi-static approximation, attenuation of the fields, time and frequency domain measurements, electric and magnetic dipole source in free-space, conductive whole space, above layered earth, and near two- and three-dimensional targets. In addition the various electromagnetic systems for near-surface investigations, their responses and anomalies and the effect of conductive host medium and overburden layer and data interpretation are studied. Modelling and interpretation software are used in computer exercises to emphasise the lectures.

Mode of delivery: Face to face

Learning activities and teaching methods:
- Lectures 20 h, demonstrations 20 h and practical work, self-study 93 h

Target group: MSc students of geophysics. Also for the other students of the University of Oulu.

Pre-requisites and co-requisites: No specific prerequisites

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.

Recommended or required reading:

Assessment methods and criteria: Examination and approved report
- Grading: 5-1/fail
- Person responsible: N.N.
- Work placement: No work practise

762609S Modelling and inversion
Mallinnus ja inversio
ECTS credits: 5 cr
Language of instruction: Finnish
Timing: 4th or 5th study year
Learning outcomes: After passing the course the student can describe essential things of geophysical interpretation methods, can define and explain geophysical tomography, the theoretical basics of non-linear optimisation and inversion and is able to
apply them in interpretation of geophysical data.


Mode of delivery: Face to face

Learning activities and teaching methods: Lectures and exercises totalling 55 h, self-study 105 h.

Target group: Compulsory for students of geophysics in the M.Sc. degree.

Pre-requisites and co-requisites: No specific prerequisites

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.


Assessment methods and criteria: One written examination and accepted report of an independent exercise

Grading: 5-1/fail

Person responsible: Elena Kozlovskaya

Work placement: No work practice
Contents: Magnetic, gravimetric, electric, electromagnetic, radiometric, seismic and other methods applicable in borehole measurements.

Mode of delivery: Face to face

Learning activities and teaching methods: Lectures and exercises totaling 30 h, additional independent study.

Target group: Students of Oulu Mining School, and the Faculties of Science and Technology. Obligatory to geophysics students in M.Sc. degree.

Pre-requisites and co-requisites: Prior completion of course 762305A (earlier 762302A) Geophysical research methods of rock and soil.

Recommended optional programme components:

Recommended or required reading: Material given during lectures

Assessment methods and criteria: Examination

Grading: 5-1/fail

Person responsible: Kari Moisio

Work placement: No work practise

762646S Field course in environmental geology and applied geophysics
Ympäristögeologian ja geofysiikan maastokurssi
ECTS credits: 3 cr

Timing: 4th or 5th study year

Learning outcomes: After completion the student know how to make field measurements related to environmental research and know better the requirements of data processing, interpretation, and reporting.

Contents: The course introduces the students of geophysics with various geological problems and gives the students of geology practical information about the methods of applied geophysics. The geological problems include peat bog, esker, hummocky moraine, clay layers and thick overburden. The geophysical methods include ground penetrating radar method and seismic, electrical and electromagnetic soundings. The course starts with four days of field work, after which the student groups process and interpret the collected geological and geophysical data themselves and report their results.

Mode of delivery: Face-to-face teaching.

The course is arranged every two or three years

Learning activities and teaching methods: 32 h field work, 20 h processing and interpretation of measured data, approved written report, self-study 28 h

Target group: Compulsory in MSc studies of geophysics.

Pre-requisites and co-requisites: Prior completion of course 762305A (earlier 762302A) Geophysical research methods of rock and soil.

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously.


Assessment methods and criteria: Participation and approved written report

Grading: Pass/fail

Person responsible: N.N.

Work placement: No
of diploma/master’s thesis.

Mode of delivery: Blended teaching: lectures, web-based learning material and exercises in Optima environment, personal guidance.

Learning activities and teaching methods: Lectures 6h, self-study 20h, personal guidance 1h

Recommended or required reading: Parts of the following chapters of the Toolbox of Research:
https://wiki.oulu.fi/display/tor/1.1+Finding+scientific+information
https://wiki.oulu.fi/display/tor/1.3.1+Evaluation+based+on+academic+publishing

Assessment methods: Passing the course requires participation in the lectures (6h) and personal guidance and successful completion of the course assignments.

Grading: pass/fail

Person responsible: Science and Technology Library Tellus, tellustieto (at) oulu.fi

Other information: http://www.kirjasto.oulu.fi/index.php?id=1250

POSTGRADUATE STUDIES

771601J Postgraduate courses completed in other domestic or foreign university
Toisessa kotimaissessa tai ulkomaalaisessa yliopistossa suoritetut jatkokurssit

ECST credits: 2-30 cr

Language of instruction: Dependent on the country (usually English)

Timing: During PhD studies

Learning outcomes: Dependent on the course

Contents: Vary case by case.

Target group: All postgraduate students in geosciences visiting another university.

Pre-requisites and co-requisites: Accepted study right in the University of Oulu Graduate School

Assessment methods and criteria: Dependent on the course

Person responsible: Supervisor

771602J Licentiate thesis
Lisensiaatin tutkielma

ECST credits: 90 cr

Language of instruction: Finnish or English

Timing: At the end of postgraduate studies. The student should be able to complete all studies for the licentiate degree including the thesis and other studies within three years of full-time study.

Learning outcomes: Learning outcomes include the student’s ability to use independently scientific research methods and produce scientific research articles.

Contents: Vary case by case.

Mode of delivery: Independent research work and personal supervision

Learning activities and teaching methods: Independent research work and personal supervision

Target group: All geoscience students who want to do the Licentiate degree after their Master’s degree.

Pre-requisites and co-requisites: A requirement for admission to postgraduate studies is completion (with good grades) of an applicable university degree

Recommended optional programme components: The course is an independent entity and does not require additional studies carried out at the same time.

Recommended or required reading: Literature related to the research topic

Assessment methods and criteria: The Licentiate thesis is a written document on a research problem and its scientific solution. The thesis should show the student’s capability to employ independently relevant research method for solving the problem. The thesis can be a monograph or a collection of two or more separate articles coupled with their synopsis, dealing with the same general problem. In these articles there may also be other authors that the student, but the student needs to have an independent and significant role in each of them.

Grading: Pass with distinction/pass/fail

Person responsible: Principal supervisor

Work placement: May contain if the subject is related to the work of the student.

771603J Doctoral dissertation
Väitöskirja

ECST credits: 90 cr
**Geotieteiden koulutusohjelma**

**Language of instruction:** Finnish or English  
**Timing:** After completion of the Master's or Licentiate degree. The student should be able to complete all studies for the doctoral degree including the thesis and other studies within four years of full-time study and the dissertation is normally completed at the end of the studies.

**Learning outcomes:** Learning outcomes include the student's ability to utilise independently scientific research methods, solve scientific problems and produce scientific research articles.

**Contents:** Vary case by case.

**Mode of delivery:** Independent research work and personal supervision.

**Learning activities and teaching methods:** Independent research work and personal supervision.

**Target group:** All geoscience students who have completed their applicable Licentiate degree or their Master's degree with good grades (min. 3/5) and have a study plan accepted by UniOGS.

**Pre-requisites and co-requisites:** A requirement for admission to postgraduate studies is completion (with good grades) of an applicable higher university degree.

**Recommended optional programme components:** The course is an independent entity and does not require additional studies carried out at the same time.

**Recommended or required reading:** Literature related to the research topic.

**Assessment methods and criteria:** The doctoral student writes a thesis, which should show evidence that he/she can independently and critically apply scientific research methods and generate new scientific knowledge. A doctoral thesis can be a compilation of published research articles and manuscripts, and a summary based on these, or it can be a monograph. A compilation-based thesis may include multiple published articles, accepted manuscripts or other manuscripts, but a single article published, or accepted for publication, in a high-quality scientific journal can be sufficient. The doctoral thesis may contain joint publications, or manuscripts, if the independent contribution of the doctoral student can be clearly demonstrated (see http://www.oulu.fi/tutkijakoulu/).

**Grading:** Pass with distinction/pass/fail

**Person responsible:** Principal supervisor

**Work placement:** May contain if the subject is related to the work of the student.

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**771604J Licentiate examination**  
Lisensiaatin kuulustelu  
**ECST credits:** 9 cr  
**Language of instruction:** Finnish or English  
**Timing:** During postgraduate studies. The course is part both of the licentiate or doctoral studies and is commonly done in a late stage of the studies.

**Learning outcomes:** After the course the student has deepened his/her knowledge on a wide topic related to his/her licentiate or doctoral studies.

**Contents:** Depends on the research field of the student.

**Mode of delivery:** Independent study.

**Learning activities and teaching methods:** The student studies independently one or more text books related to the research field.

**Target group:** Phil.Lic. and PhD students in geosciences

**Pre-requisites and co-requisites:** A requirement for admission to postgraduate studies is completion (with good grades) of an applicable Master's level degree.

**Recommended optional programme components:** No alternative course units or course units that should be completed simultaneously.

**Recommended or required reading:** Selected separately for each student.

**Assessment methods and criteria:** Written examination.

**Grading:** 5-1/fail

**Person responsible:** Principal supervisor

**Work placement:** May contain a work placement period.

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**771605J Teaching tasks**  
Opetustehtävät  
**ECST credits:** 1-6 cr  
**Language of instruction:** Finnish or English  
**Timing:** During postgraduate studies

**Learning outcomes:** The aim of the course is to reinforce the doctoral student's ability to teach and support construction of his/her teaching identity. The student is able to teach and/or supervise.

**Contents:** The main tasks of PhD students in the Geosciences degree programme are gaining expertise on his/her field of specialty,
carry out research in this field and pass successfully exams of the courses agreed in the post-graduate study plan. Apart from these, he/she should be able to paraphrase novice students, colleagues and ordinary citizens about geological theories and his/her own research field. This training is aimed at introducing post-graduate students to clear and natural performance in various teaching events and in later tasks outside university. Training is documented in the post-graduate study plan.

Mode of delivery: Face to face

Learning activities and teaching methods: Participation in the teaching of a course

Target group: PhD students in geosciences

Pre-requisites and co-requisites: Students must have gained at least 2 ECTS from university pedagogic studies or equivalent training

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously

Recommended or required reading: Course material

Assessment methods and criteria: The course gives 6 ECTS credits at the maximum. Each teaching period of 80 hours during an academic year results in 2 ECTS credits.

Grading: Pass/fail

Person responsible: Principal supervisor

Work placement: Includes work placement period

771606J Scientific conferences

Tieteelliset kokoukset

ECST credits: 1-7 cr

Language of instruction: Dependent of the conference (commonly English or Finnish)

Timing: During postgraduate studies

Learning outcomes: The doctoral student is able to communicate her/his results, initiate new research contacts, acquire new knowledge in the field and apply new ideas to her/his own research.

Contents: Oral or poster presentation in a conference, assisting in conference organisation

Mode of delivery: Attendance to conferences and/or participation to organizing of conferences

Learning activities and teaching methods: Preparation of a conference talk or poster and its presentation

Target group: PhD students in geosciences

Pre-requisites and co-requisites: Active ongoing research related to doctoral studies

Recommended optional programme components: No alternative course units or course units that should be completed simultaneously

Recommended or required reading: Literature related to the research topic

Assessment methods and criteria: - National conference - poster 0.5 ECTS credits - National conference - oral presentation 1.0 ECTS credits - International conference - poster 1-2 ECTS credits - International conference - oral presentation 2-3 ECTS credits - Participation in conference organisation 0-1 ECTS credits

Principal supervisor evaluates the ECTS points depending on the presentation forum, based on the tradition on the specific research field

Grading: Pass/fail

Person responsible: Principal supervisor

Work placement: No work placement period

771607J Research visit

Tutkimusvierailu

ECST credits: 0.5-2 cr

Language of instruction: Finnish or English

Timing: During postgraduate studies

Learning outcomes: The doctoral student is able to acquire new knowledge, experience, and ideas in a new research environment

Contents: Research work related to the dissertation under the guidance of a local supervisor

Mode of delivery: Depending on the work

Learning activities and teaching methods: The supplement of the doctoral research work of the student in a different national or international research environment. The duration of the visit needs to be at least 1 week.

Target group: PhD students in geosciences

Pre-requisites and co-requisites: Active ongoing research related to doctoral studies

Recommended optional programme components: No alternative course units or
course units that should be completed simultaneously

**Recommended or required reading:** Literature related to the research topic

**Assessment methods and criteria:** Documented attendance. Principal supervisor evaluates the ECTS points depending on the duration and content of the research visit.

**Grading:** Pass/fail

**Person responsible:** Principal supervisor

**Work placement:** No work placement period

771608J Research plan and seminar
Tutkimussuunnitelma ja seminaari
ECTS credits: 1 cr

**Language of instruction:** English (or other, when appropriate)

**Timing:** During the first year of doctoral training

**Learning outcomes:** After the course, the student is able to present and discuss his/her research progress in oral form, and has learned how to critically evaluate the research of others. He/she knows other doctoral students in their field of science.

**Contents:** Presentation of the research in the form of a public research plan seminar or a research seminar.

**Mode of delivery:** Personal work, seminar

**Learning activities and teaching methods:** Preparation and presentation of a talk on his/her research plan and research results

**Target group:** PhD students in geosciences

**Pre-requisites and co-requisites:** The student must have been granted the study rights for doctoral training at the University of Oulu Graduate School and a doctoral training follow-up group must have appointed to him/her.

**Recommended optional programme components:** This is the seminar organised by the faculty and is part of the UniOGS course 920004J-01 Research plan and seminar (4 ECTS credits).

**Recommended or required reading:** Background literature of own research field.

**Assessment methods and criteria:** Public presentation of the research plan/results in a research (plan) seminar.

**Grading:** Pass/fail

**Person responsible:** Responsible persons of the relevant Majors/fields of doctoral studies

**Work placement:** No work placement period

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## Contact information and staff

**Study Affairs:**

Service Centre for Study Affair (YL 130-2), study.oms@oulu.fi

Dean: Professor Juha Pekka Lunkka, phone 0294481434
Dean for Education: Professor Eero Hanski, phone 0294481461

**Teaching staff:**

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