



ALMA MATER STUDIORUM
UNIVERSITA DI BOLOGNA



Norwegian University of
Science and Technology



GTK: GEOLOGICAL SURVEY
OF FINLAND



RawMaterials

RAW Materials Exploration and Sustainability

COURSE NAME: Primary Mineral Deposits

CONTACT INFORMATION

Professor/Instructor: Paolo S. Garofalo

University/Company/Institution: University of Bologna Dept of Biological, Geological and Environmental Sciences

E-mail Address: paolo.garofalo@unibo.it

Webpage: <https://www.unibo.it/sitoweb/paolo.garofalo/teachings>

COURSE CONTENT AND INTENDED LEARNING OUTCOMES (ILOs)

The objective of this course is giving the students a system and integrated view of the geological processes that lead to the genesis of the main primary mineral deposits using a combination of field, laboratory, and numerical methods. The fundamental subjects of this course will be the geological characteristics of the most important classes of ore deposits, which include the magmatic, magmatic-hydrothermal, hydrothermal exhalative, orogenic-Au, Mississippi valley type, banded iron formations (BIF), and placer classes. The geothermal fields will be considered as proxies of currently forming ore deposits. The scientific methods used in the course will be field mapping of ore bodies and wallrock alteration, the petrographic, mineralogical, and geochemical study of ore bodies and wallrock alteration; the fluid inclusion studies; the stable isotope studies; the fluid-rock equilibria. At the end of the course the students will learn how to distinguish and identify with various techniques samples from different deposit types.

Summary bullet list of expected, course-specific learning outcomes:

At the end of the course, students will be able to:

- Identify the main geological environments and processes that generate primary mineral deposits;
- Use a set of geological tools to distinguish between different types of mineral deposits;
- Read and interpret some basic and advanced field and laboratory techniques with which primary mineral deposits are documented;
- Combine critically the gathered knowledge to determine which geological dataset is necessary for the definition of the genetic model of a given deposit, as well as its successful exploration/exploitation.

Aligning with the EIT OLOs: please tick **X** at least two EIT OLOs that your course contributes to reach.

X EIT OLO 1 - Making value judgments and sustainability competencies

The ability to identify short- and long-term future consequences of plans and decisions from an integrated scientific, ethical and intergenerational perspective and to merge this into a solution-focused approach, moving towards a sustainable society.

2 = highly relevant to course content

This course provides a background knowledge on the different types of primary mineral deposits, on their commodity endowment, on their typical geological occurrences, on the tools for their mapping and documentation, and also on how economic mineral assemblages are interlocked at various scales within the ore body by natural processes. This is key fundamental knowledge on mineral deposits

Please note that this information is subject to change. Refer to the online version for any updates.



(i.e., starting point of the raw material value chain), which is at the heart of relevant economic evaluation of ore bodies, decisions on exploitation techniques, sustainable mining, and business planning in general.

EIT OLO 2 - Entrepreneurship skills and competencies

The ability to translate innovations into feasible business solutions

EIT OLO 3 - Creativity skills and competencies

The ability to think beyond boundaries and systematically explore and generate new ideas.

2 = highly relevant to course content

The study of the genesis of ore deposits is a classic research discipline, probably one of the first to be established historically in geology. To date, looking at the breath of the scientific literature, this discipline is still research-based to a large extent. The potentiality to build cutting-edge skills and competencies in the students is therefore high, but these skills are especially needed if new ideas and concepts are to be found for an efficient exploration and exploitation in the future. Creation of successful new ventures looking at sustainable exploration and exploitation will probably pass through sharper and more detailed ore deposit modelling.

EIT OLO 4 - Innovation skills and competencies

The ability to use knowledge, ideas and technology to create new or significantly improve products, services, processes, policies, new business models or jobs.

1 = peripherally relevant to the course content

Because ore deposit characteristics are defined by a combination of distinct documentation techniques that vary – from the regional scale to the microscopic scale – as a function of a large number of factors, mineral deposit studies are inherently multi-disciplinary and require an inquisitive approach. Economic geologists need to combine a large number of data to build a sound genetic model of an ore deposit. To make this discipline ready for the future challenges, this course enriches the classic lectures and field activities with laboratory exercises and seminars by industry/university researchers to present a blend of approaches to mineral deposit studies. Such combination is ideal to foster trans-disciplinary thinking and a broad range of competencies in the students.

EIT OLO 5 - Research skills and competencies

The ability to use cutting-edge research methods, processes and techniques towards new venture creation and growth and to apply these also in cross-disciplinary teams and contexts

EIT OLO 6 - Intellectual transforming skills and competencies

The ability to transform practical experiences into research problems and challenges

2 = highly relevant to course content

This course offers the potential for developing a number of practical experiences of ore deposit studies via the setup of MSc theses in tandem with mine companies and internship projects with the Rames partners. All these experiences might provide chances to apply ore deposit knowledge beyond the classic academic boundaries. This course might also interact with the other MSc courses on business/economy to explore potential new avenues of mineral deposit studies. This potential coupling of ore deposit studies and business/entrepreneurship applications is a distinct challenging field of development of this MSc programme.

EIT OLO 7 - Leadership skills and competencies

The ability of decision-making and leadership, based on a holistic understanding of the contributions of higher education, research and business to value creation, in limited sized teams and contexts.

Please note that this information is subject to change. Refer to the online version for any updates.



ALMA MATER STUDIORUM
UNIVERSITA DI BOLOGNA



Norwegian University of
Science and Technology



GTK: GEOLOGICAL SURVEY
OF FINLAND



RawMaterials

ASSESSMENT METHODS AND GRADING SYSTEM

Considering the learning objectives and the teaching methods, the assessment will take into account the following components:

1. Level of independence and effectiveness during fieldwork
2. Level of independence and effectiveness during laboratory exercises
3. Class contribution
4. Written test
5. Oral exam.

The combination of these components will be important to evaluate the EIT OLOs 1, 3, and 6, which are the most relevant of the course. The oral part of the exam, in particular, has the objective to assess the level of competencies and knowledge creativity, which helps the evaluation of EIT OLO 4.

The grades in the Italian university system are expressed out of thirty. The passing grade is 18/30. In case of full grade (30/30) the Professor(s) may also decide to award honours (lode).

Below there is the breakdown of the final grade:

| ASSESSMENT METHOD | WEIGHT ON FINAL GRADE |
|---------------------|-----------------------|
| Fieldwork | 20% |
| Laboratory | 20% |
| Class participation | 10% |
| Written test | 25% |
| Oral exam | 25% |