MISKOLCI EGYETEM

MŰSZAKI FÖLD- ÉS KÖRNYEZETTUDOMÁNYI KAR

ANALYTICAL TECHNIQUES IN MINERALOGY AND PETROLOGY

MSc in Earth Science and Engineering

2022/23 II. semester

COURSE COMMUNICATION FOLDER

University of Miskolc
Faculty of Earth and Environmental Sciences and Engineering
Institute of Exploration Geosciences

Datasheet of the course

Course title: Analytical techniques in mineralogy and petrology **Teacher:** Dr. Zajzon Norbert, associate professor	**Code of the course:** MFFAT720025 **Responsible institute:** Institute of Exploration Geosciences **Type of course: C**
Recommended semester: 2	**Pre-requisites:** none
No. of contact hours/week (sem.+lab.): 1+1	**Type of assessment (exam/pr. mark/other):** pr. mark
Credit points: 2	**Course:** full-time

Task and target of the course: The key target of the course is to introduce the different analytical methods used in mineralogy and geology for the students. There are laboratory classes with individual work about the learned methods nearby the theoretical classes. Thru these exercises the students learn what is the best available method to answer certain geological questions.

Competencies to evolve:

Knowledge: Differentiates the processes described by the general and specific theories required for the practicising of the fields of earth science engineering, categorizes the internal connections between geological processes, and designs the planning and interpretation procedures. Combines the technical and scientific knowledge required for the high-level integration in earth sciences engineering disciplines, among others in numerical methods, technical physics and their contexts. Categorizes the components of the raw material extraction sector, the technologies used for the extraction and preparation of mineral raw materials, as well as the scope of geo-environmental tasks, their external socio-economic environment and regulatory system. Utilizes the best practices applied to earth science engineering tasks and the long-term development directions that can be expected in this field in the medium term. Chooses the geological and geophysical methods suitable for exploring natural resources. Distinguishes between the methods of exploring mineral deposits. Elaborates a sound application practice on the methods of acquisition and data collection in the applied earth sciences, and on their instrumental measurement and IT data processing procedures.

Ability: Applies general and specific scientific theories pf applied earth sciences, systematizes them, solves independent engineering tasks (mainly complex geological prospecting, final report summarizing exploration results, geological-geophysical parts of environmental impact assessments). Composes presentations and written documents in Hungarian or in a foreign language. Performs complex planning, construction, inspection and official licensing tasks (geological-geophysical exploration plans of natural resources, acquisition of environmental geology), innovatively uses the theories and terminology of applied earth science knowledge. Organizes, manages, and supervises complex activities based on or incorporating applied earth science tasks (especially mining, environmental technology investments, operations). Contributes to the solution of geological-geophysical tasks arising during the extraction of mineral raw materials (planning, investment, operation, closure) and to analyzes the possible solutions. Identifies the structure of the raw materials extraction sector, the technologies used for the extraction and processing of mineral raw materials, as well as the scope of geo-environmental tasks, their external socio-economic environment and regulatory system. Maximizes the cooperation with related disciplines and manages the (working) group within the framework of larger and more complex activities, based on or incorporating applied earth science tasks.

Attitude: Percieves the professional and technological methodological developments in the fields of applied earth sciences, participates in their development. Applies innovative skills and knowledge in solving professional problems in the fields of earth science engineering. Commits and convincingly demonstrates to knowing and adhering to the professional and ethical values. Maximizes professionalism and professional solidarity. Respects and follows the ethical principles and written rules of work and professional culture in activities, follows them when managing small workgroups. Has a sufficient motivation to carry out activities in often changing working, geographical and cultural circumstances.

Autonomy and responsibility: Plans the work independently, and rules on to lead workgroups. Takes responsibility and is accountable for the work processes carried out under his / her control. Makes decisions carefully, in consultation with representatives of other disciplines (primarily legal, economic, and environmental), independently, Takes responsibility for decisions. Develops professional decisions in the field of operation entrusted to him/her. Committed to the practice of sustainable natural resource management, occupational health and safety.

Thematic description of the course:

1. Description of the work, formulating analytical pairs, work and lab safety teaching
2. Physical properties (hardness, magnetic, solubility, density), density measurements
3. X-ray diffraction lecture I.
4. X-ray diffraction lecture II.
5. X-ray diffraction practice
6. DTA lecture
7. DTA quantitative calculations
8. Writing of test 1.
9. Scanning electron microscopy lecture I.
10. Scanning electron microscopy lecture II.
11. Scanning electron microscopy practice
12. Formula calculations
13. Consultation
14. Writing of test 2.

Type of assessment during the semester: There are two written tests about the theoretical part (50% of the final grade). Both must be written to minimum 50%. Two laboratory report must be written about the individual work (50% of the final grade). Missing, or not passed tests can be completed at the end of the semester in oral exam. To have accepted grade, the student must be present at least 80% of the classes.

Grading limits:
> 80 %: excellent
70 – 80 %: good
60 – 70 %: average
50 – 60 %: satisfactory
< 50 %: unsatisfactory

Recommended literature:

Reed SJB (2005): Electron Microprobe Analysis and Scanning Electron Microscopy in Geology. Cambridge University Press.
O'Donoghue M (2006): Gems: Their sources, descriptions and identification. Elsevier.
Pracejus B (2008): The ore minerals under the microscope: an optical guide. Elsevier.
Goldstein J et al. (2003): Scanning Electron Microscopy and X-ray Microanalysis. Kluwer Academic/Plenum Publishers.
King M. et al. (1993): Mineral Powder Diffraction File Search- and Databook. ICDD, USA.

Description of the course

Advanced mineralogy

2022/23 year, II. semester
Time of lectures and laboratories: Friday, 12:00-14:00

Week	Topic of the class
2023.03.03.	Description of the work, formulating analytical pairs, work and lab safety teaching
2023.03.10.	Physical properties (hardness, magnetic, solubility, density), density measurements
2023.03.17.	X-ray diffraction lecture I.
2023.03.24.	X-ray diffraction lecture II.
2023.03.31.	X-ray diffraction practice
2023.04.07.	Holiday
2023.04.14.	DTA lecture
2023.04.21.	DTA quantitative calculations
2023.04.28.	Scanning electron microscopy lecture I.-II.
2023.05.05.	Rector"s day

2023.05.12.	Scanning electron microscopy practice
2023.05.19.	Consultation
2023.05.26.	Writing of test 1 / 2.

Example of the written test

Written test of Analytical technics in mineralogy and petrology 1

1. How is the exfoliation of the calcite, and how many directions it has? And what kind of geometric shape is formed by (3)?
2. List the Mohs-scale (3).
3. How characteristic X-ray radiation is created (2)?
4. How characteristic X-ray radiation can be monochromatised (2)?
5. Why do we use monochromatic radiation for X-ray diffraction (XRD) instead of continuous (2)?
6. Draw and X-ray powder diffractometer with goniometer, and also a Gandolfi-camera (3).
7. What kind of X-ray sources you know (for diffraction) (2)?
8. What are the main points for choosing filter for the different X-ray sources? Give examples (2).
9. Write down the Braggs-law, and explain the parts (3).
10. What are the advantages and drawbacks of the goniometer and Gandolfi-camera during XRD (2).
11. What is the optimal grain size for XPRD, and why (2)?
12. Explain the idea of parallel beam geometry for XRD (3).
13. What is the advantage of the parallel beam geometry compared to Bragg-Brentano geometry (2)?

Written test of Analytical technics in mineralogy and petrology 2

1. Make a schematic drawing of a SEM-EDX system (3).
2. Make a schematic drawing of an electron gun, where is it located, and what is the purpose of it (2)?
3. Why do we need to produce vaacum in any electronmicroscope (1)?
4. Why do we call it “<u>Scanning</u>” Electron Microscopy? How that part works? Make a schematic drawing also (3).
5. What kind of particles and radiations are created during the interaction of electron beam and thick smple (4)?
6. What is the difference between BSE and SE images (what can be seen in the picture, for what purpose you would use them…) (3)?
7. How characteristic X-ray radiation forms (2)?
8. How big is the smallest area of a solid matter from where individual chemical analysis can be performed by EDX or WDX? And what parameters define the exact size (3)?
9. Make a schematic drawing of a WDX spectrometer (2).
10. Why do we need to use standards for accurate measurements for EDX and WDX (2)?
11. Compare the advantages and disadvantages of EDX and WDX systems (speed, detection limit, accuracy, resolution price…) (4)?
12. Which method can separate the following mineral pairs from each other, EDX or WDX: aragonite-calcite, magnetite-hematite and pyrope-almandine (3)?