



GEOPHYSICAL INTERPRETATION AND PROSPECTING

Earth Science Engineering MSc Course

2026/2027 / 1st semester

COURSE COMMUNICATION FOLDER

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

Course datasheet

Course title: Geophysical interpretation and prospecting Instructor: Dr. Ernő Takács, PhD Geoscience Referee at the Unit of Mineral Exploration, Supervisory Authority for Regulatory Affairs Co-lecturers: A. Kiss, E. Nádasi, M. Kis, I. Csató, T. Lukács, Z. Püspöki	Code: MFGFT730025 Responsible department / institute: Department of Geophysics / Institute of Exploration Geosciences Type of course: Compulsory
Position in curriculum (which semester): 3	Pre-requisites (if any)
No. of contact hours per week (lecture + seminar): 2+2	Type of assessment (examination / practical mark / other): examination
Credits: 4	Course: full time
Course description: The aim of the course is to provide comprehensive knowledge about the different phases of geophysical exploration (survey planning, data acquisition, data processing, interpretation and prospecting). Students will learn the linkage between different geophysical methods. They will study how to set up the most probable geological-structural model by utilization of the available geophysical data and other geoscience information. They will get an overview of the variety of geophysical methods and will learn about the most effective procedures applied in geophysical exploration targeting different kinds of local natural resources (ore minerals, hydrocarbons, geothermal energy, coal-seams and aquifers). Large-scale regional structural investigations and small-scale geoengineering tasks will also be demonstrated. The most important practical issues will be discussed in seminars. Competencies to evolve: Knowledge: T1, T2, T3, T4, T5, T7, T8, T9 Ability: K1, K2, K3, K5, K6, K7, K8, K9, K10, K11, K12, K13 Attitude: A1, A2, A3, A4, A5, A7 Autonomy and responsibility: F1, F2, F3, F4, F5	

Short curriculum of the subject:

- 1) Formation of the unconformity type uranium deposits. Geophysical methods applied in the exploration. The 'seismic uranium indicators' (case studies from Canada).
- 2) Lithological reasons of the seismic amplitude anomalies. Post- and pre-stack inversion techniques applied in HC exploration. Joint utilization of well-log and seismic data.
- 3) Propagation of the elastic waves and the basics of seismic data processing. The specialty of the Pannonian Basin from geological-geophysical point of view.
- 4) The main elements of structural geology and basin analysis, types of hydrocarbon traps. Case studies on reservoir identification using well-log and seismic data.
- 5) Well-logging techniques to obtain in-situ rock-physical parameters and lithological information. The bridge between the sonic and density logs and the surface seismic data.
- 6) Tracing coal seams and aquifers based on well-log and seismic data. Case studies on structural development models and deformation history.
- 7) Mapping structural (tectonic) trends based on gravity data. The advantage for regional investigations and local geophysical survey design.
- 8) Mapping structural (tectonic) trends based on MT data. The advantage for regional investigations and local geophysical survey design.
- 9) Basics and practical applications of GPR measurements. Scanning the near-surface zone, looking for inhomogeneities to support geoengineering tasks.
- 10) Rock-physical models. Forward and inverse modelling. Different geophysical inversion procedures for different geological tasks.

Assessment and grading:

During the semester the following tasks have to be completed: a report covering the aims of the practical exercise (60%), and a successful exam (40%). Grading limits:

> 80%: excellent,

70-79%: good,

60-69%: medium,

50-59%: satisfactory,

< 50%: unsatisfactory.

Recommended literature:Related books:

1. Bacon, M., Simm, R., Redshaw, T.: 3-D Seismic Interpretation, 2003
2. Chopra, S. and Castagna, J.P.: AVO, Investigations in Geophysics 16, Society of Exploration Geophysicist, Tulsa, Oklahoma, 2014
3. Kearey, P., Brooks, M., Hill, I.: An Introduction to Geophysical Exploration, 2002
4. O. & L. Serra: Well Logging Data Acquisition and Applications, Serra Log, 2004
5. Jacoby, W., Smilde P. L.: Gravity Interpretation. Fundamentals and Application of Gravity Inversion and Geological Interpretation. Springer-Verlag Berlin Heidelberg, 2009
6. Chave, A.D. and Jones, A.G.: The Magnetotelluric Method: Theory and Practice, Cambridge University Press, 2012

Periodicals for attention: The Leading Edge, First Break, Geophysical Prospecting

Syllabus of the semester

Date	Lecture
Sep 09	Introduction to the course
Sep 16	Uranium exploration in the Athabasca Basin, Canada
Sep 23	University Sport Day
Sep 30	Direct Hydrocarbon Indicators and AVO analysis
Oct 07	Elastic wave propagation and seismic data processing
Oct 14	Seismic interpretation for HC exploration
Oct 21	Professional Day
Oct 28	Holiday declared by Rector
Nov 04	Basics and applications of the well-logging methods
Nov 11	Coal and aquifer stratigraphy using well-log and seismic data
Nov 18	Basics and applications of the gravity method
Nov 25	Basics and applications of the MT method
Dec 02	Basics and applications of the GPR method
Dec 09	Rock-physical models and inversion techniques

Date	Seminar
Sep 09	Aim and topics
Sep 16	Building geological models based on geophysical data (G&G)
Sep 23	University Sport Day
Sep 30	Hilbert and AVO attributes from practical viewpoint (fluid detection)
Oct 07	Why is the Pannonian Basin so special?
Oct 14	Case studies from all around the world (reservoir identification)
Oct 21	Professional Day
Oct 28	Holiday declared by Rector
Nov 04	The bridge between the well-log and surface seismic data
Nov 11	Case studies from the coal and aquifer exploration (Pannonian Basin)
Nov 18	Advantages of the gravity method
Nov 25	Advantages of the MT method
Dec 02	Geoengineering tasks for GPR measurements
Dec 09	Forward and inverse modelling

Sample questions for the final exam with answers

1. What kind of geophysical methods are utilized for the unconformity-type uranium exploration in the North Canadian Shield?

Actually, every geophysical method (gravity, magnetic, geoelectric, reflection seismic, well logging, rock sample measurements).

2. What are the seismic ‘uranium indicators’?

Fracture zone in the basement, low-reflectivity sandstone/basement unconformity, high-energy but chaotic reflections in the sandstone.

3. How do you classify the seismic noises? Provide some examples of unwanted events from the viewpoint of reflection processing.

Linear and random noises. Ground roll, airwave, first arrivals, wind, rain, and human activity in the survey area (e.g. agricultural work or traffic)

4. What are the ‘direct hydrocarbon indicators’ and what kind of seismic attributes are used to recognize them?

Flat spot, bright spot, dim spot, polarity reversal, and low frequency reflections. Reflection strength, instantaneous phase, apparent polarity, and instantaneous frequency.

5. What are the basic AVO attributes and what kind of other helpful attributes can be derived from them? Define the acoustic and elastic impedances (AI and EI).

Intercept (A) and gradient (B), AVO product ($A*B$), shear-wave reflectivity ($A-B$), and scaled Poisson’s ratio change ($A+B$). $AI = V_P*\rho$, $EI = \lambda*\rho$ and $\mu*\rho$.