MISKOLCI EGYETEM
MŰSZAKI FÖLDTUDOMÁNYI KAR
1735

GEOPHYSICAL EXPLORATION METHODS I.

MS in Earth Science Engineering

First semester 2020/2021

COURSE COMMUNICATION DOCUMENT

University of Miskolc
Faculty of Earth Science and Engineering
Institute of Geophysics and Geoinformatics

Course datasheet

Course title: Geophysical exploration methods I. **Responsible professors**: Norbert Péter Szabó Dr., PhD, dr. habil., university full professor László Gombár Dr., honorable associate professor	**Code**: MFGFT7100021 **Responsible Institute/Department**: Institute of Geophysics and Geoinformatics / Department of Geophysics
Semester: first	**Pre-requisites**: MFGFT6002D, MFGFT6003D
Number of Contact Hours per Week: 2 lec. + 1 lab.	**Type of Assessment** (exam. / pr. mark. / other): exam (oral)
Credits: 4	**Type of Program**: full time **Program and Specializations**: MS in Earth Science Engineering, Geological Engineering, Geophysical Engineering and Geoinformatics Engineering specializations

Study goals:

Understanding the surface geophysical methods and the geophysical methods used in boreholes for the purpose that students can design and execute geophysical research and evaluate data.

Competencies to be developed:

Knowledge: T1, T2, T4, T7, T8, T9
Ability: K1, K2, K3, K5, K9, K11, K12, K13
Attitude: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Course content:

Gravity and magnetic methods of applied geophysics. Direct current geoelectric and electromagnetic methods. Seismic methods of applied geophysics. Basic methods of borehole geophysics. Well-logging methods. Engineering geophysical soundings (direct-push logging methods). Physical principles of the above surveying methods. Presentation of measured quantities and the correction of measurement data. Relation between the petrographic and petrophysical parameters and the quantities measured by geophysical tools. General methods for processing and evaluating geophysical data. Deterministic, statistical and inversion methods of interpretation. The problem of ambiguity in geophysical interpretation. Resolving the problem of ambiguity. Geological and environmental geological applications of applied geophysical methods.

Type of assessment:

Attendance at lectures is regulated by the university code of education and examination. Three writing tests with satisfactory results, and two assignments during the semester is the requirement of signature.

Grading scale: >86 %: excellent, 71-85 %: good, 61-70 %: medium, 46-60 %: satisfactory, <45 %: unsatisfactory.

Compulsory and recommended literature resources:

- Telford W. M., Geldart L. P., Sheriff R. E., 1990. Applied geophysics. Second edition. Cambridge University Press.
- Kearey P., Brooks M., Hill I., 2002. An Introduction to Geophysical Exploration. Third edition. Blackwell Science Ltd.
- Serra O. & L., 2004. Well logging data acquisition and application, Editions Technip.
- Szabó N. P., 2015. Geophysical exploration methods I. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.html
- Szabó N. P., 2016. Well-logging methods. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.html

Course schedule

Date	Lecture
September 9	Classification of applied geophysics methods. Gravity methods: measured quantities, basic corrections and data processing methods. Filtering gravity maps. Evaluation of measurement data for causative bodies with simple geometries.
September 16	Geological and environmental geological applications of the gravity method. Magnetic methods: measured quantities, basic corrections and data processing methods.
September 23	Reducing magnetic data to the pole. Evaluation of measurement data for magnetizable bodies with simple geometries. Geological and environmental geological applications. The specific resistivity of rocks, the concept of apparent resistivity. Direct current geoelectric methods. VES and multi-electrode measurement methods. Introduction of electromagnetic methods.
September 30	Induced Polarization (IP) in the time domain (TDIP) and the frequency domain (FDIP). Types of electric polarizations creating the IP signal and their geological background. Frequency domain electromagnetic methods (FDEM): MT and VLF methods, artificial source frequency sounding methods: measurement systems, zones around the transmitter, characteristics of the apparent resistivity and phase curves.
October 7	Time-domain electromagnetic methods (TDEM): transient, IP and ground radar methods. The transient EM measurement system and the zones around the transmitter. In the case of electrical and electromagnetic methods, the possibilities of controlling the depth of penetration.
October 14	The development of seismic reflected waves. The travel-time curve and its characteristic parameters.
October 21	Dynamic and static corrections. The common mid-point (CMP) gather. Features of seismic (TWT) sections.
October 28	Interpretation of seismic (2D and 3D) sections. Isochronal maps. Seismic stratigraphy. Vertical and horizontal resolution. Acoustic impedance, reflection and transmission coefficients. Possibilities of detecting gas reservoirs by seismic method. The bright spot.
November 4	The development of seismic refracted waves. The travel-time curve and its characteristic parameters. Processing and evaluation of refraction data. Near-surface applications.

November 11	The relationship between the petrophysical properties of rocks and parameters measured by well logging methods.
November 18	Introduction to petrophysics. Reservoir modeling. The basics of nuclear well logging methods. Determination of lithology and porosity. Presentation of main application areas.
November 25	The basics of acoustic well logging methods. Determination of sonic porosity and permeability. Presentation of main application areas.
December 2	The basics of electric well logging methods. The relation between resistivity and water saturation. Presentation of main application areas.
December 9	Possibilities for joint processing of open-hole well logging data. Cross-plot techniques. Statistical and depth-by-depth inversion methods. Principle of engineering geophysical sounding measurements. Determination of petrophysical and geotechnical properties of soils/rocks.

Date	**Seminar**
September 9	Geological and environmental geological applications of gravity methods. Description of the basic procedures used for processing and evaluating gravity data.
September 16	Geological and environmental geological applications of magnetic methods.
September 23	Description of the basic procedures used for processing and evaluating magnetic data. Description of the tasks of the first assignment (gravity and magnetic methods).
September 30	The geological and environmental geological interpretation of DC geoelectric data.
October 7	The geological and environmental geological interpretation of EM surveying data.
October 14	Writing the first test (gravity, magnetic and geoelectric methods). Principles of refraction seismic data processing I.
October 21	Principles of refraction seismic data processing II.
October 28	Tracking and correlation of reflection horizons and tectonic elements. Principles of reflection seismic data processing.
November 4	Principles of refraction seismic data processing.

November 11	Writing the second test (seismic methods).
November 18	Estimation of petrophysical parameters using well logging data.
November 25	Computer aided processing of well logging data (MATLAB exercises). Presentation of the depth-by-depth inverse problem.
December 2	Writing the third test (well logging methods).
December 9	Submission of the individual assignments. Repeating the writing tests.

Exam questions

1. Gravity methods: measured quantities, basic corrections and data processing methods. Filtering gravity maps. Evaluation of measurement data for causative bodies with simple geometries. Geological and environmental geological applications.
2. Magnetic methods: measured quantities, basic corrections and data processing methods. Reducing magnetic data to the pole. Evaluation of measurement data for magnetizable bodies with simple geometries. Geological and environmental geological applications.
3. The specific resistivity of rocks, the concept of apparent resistivity. Direct current geoelectric methods. VES and multi-electrode measurement methods. Introduction of electromagnetic methods. Induced Polarization (IP) in the time domain (TDIP) and the frequency domain (FDIP). Types of electric polarizations creating the IP signal and their geological background.
4. Frequency domain electromagnetic methods (FDEM): MT and VLF methods, artificial source frequency sounding methods: measurement systems, zones around the transmitter, characteristics of the apparent resistivity and phase curves.
5. Time-domain electromagnetic methods (TDEM): transient, IP and ground radar methods. The transient EM measurement system and the zones around the transmitter. In the case of electrical and electromagnetic methods, the possibilities of controlling the depth of penetration.
6. The development of seismic reflected waves. The travel-time curve and its characteristic parameters. Dynamic and static corrections. The common mid-point (CMP) gather. Features of seismic (TWT) sections.
7. Interpretation of seismic (2D and 3D) sections. Isochronal maps. Seismic stratigraphy. Vertical and horizontal resolution. Acoustic impedance, reflection and transmission coefficients. Possibilities of detecting gas reservoirs by seismic method. The bright spot.
8. The development of seismic refracted waves. The travel-time curve and its characteristic parameters. Processing and evaluation of refraction data. Near-surface applications.
9. The basics of nuclear well logging methods. Determination of lithology and porosity. Presentation of main application areas.

10. The basics of acoustic well logging methods. Determination of sonic porosity and permeability. Presentation of main application areas.
11. The basics of electric well logging methods. The relation between resistivity and water saturation. Presentation of main application areas.
12. Principle of engineering geophysical sounding measurements. Determination of petrophysical and geotechnical properties of soils/rocks.