FACULTY OF
EARTH SCIENCE
AND ENGINEERING

GEOPHYSICS OF EXPLORATION FOR WATER

MS in Hydrogeological Engineering

Semester 2, 2022/23

COURSE COMMUNICATION FOLDER

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

Course datasheet

Course Title: Geophysics of exploration for water **Instructors:** Péter Tamás Vass Dr., associate professor, Krisztián Baracza Dr., senior research fellow	**Code:** MFGFT720024 **Responsible department/institute:** Institute of Geophysics and Geoinformatics / Department of Geophysics **Type of course:** Compulsory
Position in curriculum (which semester): 2	**Pre-requisites (if any): -**
No. of contact hours per week (lecture + seminar): 2+2	**Type of Assessment (examination/ practical mark / other):** examination
Credits: 5	**Course:** full time

Course Description:
Students will be provided with geophysical skills applied in the exploration for water. The subject reviews the relation and system of physical, geophysical, hydrogeological and geometrical parameters determined by different geophysical methods. In the seminars students can acquire the basic processing, interpretation and management methods of geophysical data sets and come to know how to use some relevant applications.
The short curriculum of the subject:
Determination of petrophysical, physical and geometrical parameters by means of geophysical methods for water-exploration. Surveying and detailed geophysical research methods. Studying geophysical forward modeling and inverse problems related to water exploration possibilities and demands. Profiling, mapping, tomographical geophysical methods. Well-logging (borehole geophysical) methods and interpretation procedures. Complex exploration work and interpretation. Documentation for water-exploration.
Practical work: self-made solutions of simple case-study problems.
Compatencies to evolve:
Knowledge: T4, T5
Have a working knowledge of computer-aided design and analysis.
Knows and understands hydrogeological modelling techniques.
Ability: K1, K3, K5, K8, K9, K10, K12
Ability to understand the laws and relationships related to the location, movement and quality of groundwater, to apply and put into practice the knowledge acquired, and to use problem-solving techniques.
Ability to independently plan and execute tasks related to groundwater exploration, exploitation and well hydraulics at a high professional level.
Ability to apply design, knowledge and technologies related to water supply and water treatment at a high level.
Able to solve mining and pit dewatering problems at a high level.
Ability to model hydrodynamics and transport of groundwater flow systems.
Prepared to effectively apply relevant national and European professional, environmental and conservation legislation. Ability to work in compliance with EU legislation, to cooperate with foreign partners to solve the tasks required by the EU Water Framework Directive.
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Attitude: A1, A5, A6, A7, A8, A9
Open-minded and receptive, active in learning about professional and technological methodological developments in the fields of geosciences and environmental engineering, and in solving geological problems from an engineering perspective.
It is committed to lifelong learning, diversity and values.
Respect and act in accordance with the ethical principles and written rules of work and professional culture, and be able to adhere to them when managing small teams.
Adhere to and comply with health and safety, environmental protection, quality assurance and control requirements.
Characterised by intuition, consistency and a willingness to learn.
In addition to his technical and engineering background, he also has an interest in science.
Autonomy and responsibility: F1, F2, F3, F4, F5, F6
Act independently and proactively to solve professional problems
Have a responsible attitude towards the environment.
Takes decisions independently and in consultation with other disciplines (mainly legal, economic, energy and environmental), for which it takes responsibility.
In decisions, takes into account the principles and application of environmental protection, quality, consumer protection, product liability, equal access, health and safety at work, technical, economic and legal regulation and engineering ethics.
Committed to sustainable natural resource management practices.
He/she is responsible claims in expert oppinions, professional judgements and for the work carried out under his/her supervision.

Assessment and grading: Condition for obtaining the signature: the participation in 60 % of the lessons, at least. The determination of the examination grade is based on the result of examination alone. Grading scale (% value → grade): 0 – 49 % → 1 (fail), 50 – 64 % → 2 (pass), 65 – 79 % → 3 (satisfactory), 80 – 89 % → 4 (good), 90 – 100 % → 5 (excellent).
Compulsory or recommended literature resources: Edited by P. Vass: course slides converted in pdf format: http://geofizika.uni-miskolc.hu/education.html Szabó N. P., 2014. Geophysics of exploration for water. Electronic handout, p. 233. Edited by R. Kirsch, H Rumpel, W Scheer, H Wiederhold 2006: Groundwater Resources in buried Valleys – a Challenge for Geociences, Leibnitz Institute for Applied Geosciences, Hannover, Germany, ISBN-10: 3-00-020194-7 Edited by Reinhard Kirsch, 2009 : Groundwater Geophysics - A Tool for Hydrogeology, Springer-Verlag Berlin Heidelberg, ISBN: 978-3-540-88404-0 Edited by Yoram Rubin , Susan S. Hubbard, 2005 : Hydrogeophysics, Springer Dordrecht, Berlin, Heidelberg, New York, ISBN-10 1-4020-3101-7 (HB) Prem V. Sharma, 1997 : Environmental and engineering geophysics, Cambridge University Press, ISBN-10: 0521576326 Asquith, G. B, Krygowski, D., Henderson, S., & Hurley, N., 2004: Basic well log analysis,. 2nd edition, American Association of Petroleum Geologists.

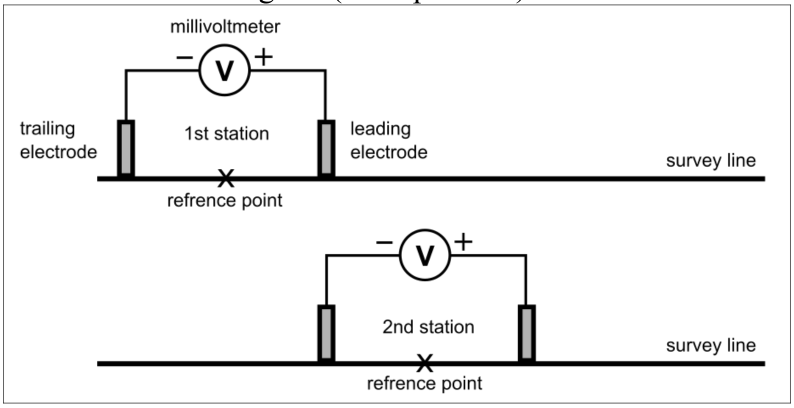
Syllabus of the semester

Date	Lecture and seminar
28/02/2023	Introduction to applied geophysics. Grouping of geophysical methods. The role of geophysical surveys in the different stages of raw material exploration.
07/03/2023	Implementation of gravity measurements and the corrections of measured data.
14/03/2023	The evaluation and interpretation of corrected gravity data. Applications in hydrogeology.
21/03/2023	Mathematical and physical basics of magnetic method.
28/03/2023	Implementation of magnetic measurements and the corrections of measured data.
04/04/2023	The evaluation and interpretation of corrected magnetic data. Applications in hydrogeology.
11/04/2023	A short review of electricity. Electrical resistivity. Resistivity of rocks
18/04/2023	Day of sport (no education)
25/04/2023	Self-potential method.
02/05/2023	Direct current resistivity methods. Vertical electrical sounding (VES).
09/05/2023	Electric profiling (EP). Continuous Vertical Electrical Sounding (CVES).
16/05/2023	Induced Polarization Method (IP).
23/05/2023	Physical basics of electromagnetic methods. The different variants of electromagnetic methods.
30/05/2023	Application of electromagnetic methods in hydrogeology.

Date	Lecture and seminar
02/03/2023	Mathematical and physical basics of gravity method.
09/03/2023	Introduction to seismic methods. Solid mechanics.
16/03/2023	Wave theory. Ray theory. Velocity of seismic waves in rocks.
23/03/2023	The main components of a seismic data acquisition system. Field techniques in seismic surveys.
30/03/2023	Seismic reflection and refraction methods.
06/04/2023	The basics of seismic data processing.
13/04/2023	Well logging equipment. Borehole environment, mud invasion.
20/04/2023	Spontaneous potential logging. Caliper logging.
27/04/2023	Natural gamma ray logging.
04/05/2023	Workday without education
11/05/2023	Conventional resistivity logging.
18/05/2023	Induction logging.
25/05/2023	Logging methods used for the estimation of porosity.

Example of test paper in shallow seismic and geoelectric methods
date

1. Answer the questions below the figure. (max. points 3)



What is the name of the electrode configuration represented by the figure? …...…....…..….…...……..…..……………….….……...………..…….…..………....
……………...……………...………………… (point 1)

What is the name of the geophysical method which uses this electrode configuration? ...…...…..…………….…..……………..………………..……………..……….……..
………..…………………...……………… (point 1)

What is the name of the other electrode configuration used by this method? …………………………...…………………....……....…...………….…………...……..
………………...……………..…………….. (point 1)

2. Read the sentences below and correct them if it is required. Write the corrected versions on the dotted lines below the sentences. If you think that a statement is true, write the word "true" below the sentence. (points 6x1)

The decrease of temperature increases the conductivity of water bearing rocks.
……………………………………………………………………………………………………
…………..…………………………………………………………………………………………
……………………..

A shear wave can propagate not only in solids but fluids, because the stress field does not have a shear component during the wave propagation.
……………………………………………………………………………………………………
…………..…………………………………………………………………………………………
……………………..

An elastic body is capable of recovering its original size and shape after the stress field has been removed.
……………………………………………………………………………………………………
…………..…………………………………………………………………………………………
…………………….

In the case of shear waves, the motions of the particles in a medium are perpendicular to the direction of wave propagation.
…………………………………………………………………………………………………
…………..……………………………………………………………………………………
……………………..

The electrical resistivity (or simply resistivity) is the ability of a material to pass the flow of electric current through itself.
…………………………………………………………………………………………………
…………..……………………………………………………………………………………
……………………..

The velocity of compressional wave is significantly higher in a highly porous rock filled with water than in a tight consolidated rock.
…………………………………………………………………………………………………
………….………………………………………………………………………………………
…………………….

3. Complete the sentences with the right words. (max. points 12)

The acoustic impedance is an acoustic property of the medium and it can be calculated by the product of …………………….. and …………………….. (point 1)

In the case of sedimentary basins, the bulk density of rocks usually ……………………… with depth. (point 1)

There are two principal types of elastic waves: (point 1)
……………………………..
……………………………..

In the case of sedimentary basins, the velocity of compressional wave usually ………………….. with depth. (point 1)

In the case of sedimentary basins, the dominant frequency of seismic waves …………………….. with depth. (point 1)

In the case of sedimentary basins, the dominant wavelength of seismic waves …………………….. with depth. (point 1)

The most frequently used four elastic moduli are the following: (points 2)
…………………………….
…………………………….
…………………………….
…………………………….

A seismic field equipment is made up of the following main components: (points 2)
…………………………….,
…………………………….,

…………………………….,
……………………………..

The most important factors influencing the resistivity of rocks are the following: (points 2)
…………………………….
…………………………….
…………………………….
…………………………….

4. For the investigation of a buried valley, the following data are known:

two-way travel-time (t_0) of the seismic wave reflected from the bottom of the valley	250 ms
average wave velocity of the sedimentary sequence,	v = 1600 m/s
sampling rate (or frequency) of the seismograph,	f_S = 1000 Hz

a.) Calculate the depth of the buried valley (z). (points 2)

b.) Calculate the Nyquist frequency (f_N) belonging to the sampling rate. (point 2)

c.) Take the half of the Nyquist frequency as the dominant frequency (f) of the seismic wavelet, and calculate the horizontal resolution of the seismic reflection method (d) for the bottom of the valley. (point 4)

d.) At last, calculate the vertical resolution of the seismic reflection method (h_{min}) for the bottom of the valley. (points 2)

Maximum attainable points: 31 Attained points: ……………

Mark: ……………

range	mark
15 ≤ and < 20	2
20 ≤ and < 25	3
25 ≤ and < 28	4
28 ≤	5

Solution of example test

1.
gradient electrode configuration
self-potential method
potential (fixed-base) electrode configuration

2.
False. Corrected statement:
The increase of temperature increases the conductivity of water bearing rocks.

False. Corrected statement:
A compressional (or P-) wave can propagate not only in solids but fluids, because the stress field does not have a shear component during the wave propagation.

True

True

False. Corrected statement:
The electrical contivity (or simply contivity) is the ability of a material to pass the flow of electric current through itself.

False. Corrected statement:
The velocity of compressional wave is significantly lower in a highly porous rock filled with water than in a tight consolidated rock.

3.
The acoustic impedance is an acoustic property of the medium and it can be calculated by the product of *density* and *wave velocity*.

In the case of sedimentary basins, the bulk density of rocks usually *increases* with depth.

There are two principal types of elastic waves:
body waves,
surface waves.

In the case of sedimentary basins, the velocity of compressional wave usually *increases* with depth.

In the case of sedimentary basins, the dominant frequency of seismic waves *decreases* with depth.

In the case of sedimentary basins, the dominant wavelength of seismic waves *increases* with depth.

The most frequently used four elastic moduli are the following:
Young's modulus (or elastic modulus),
Poisson's ratio,
shear modulus,
and bulk modulus.

A seismic field equipment is made up of the following main components:
seismic source ,
geophones,
seismograph,
cables.

The most important factors influencing the resistivity of rocks are the following:
mineral composition,
porosity,
type of fluid filling the pore space,
clay volume fraction.

4 a) z=200 m   4 b) f_N=500 Hz   4 c) d=50.6 m   4 d) h_{min} = 1.2 m