SEISMIC COLLEGE

Earth Science Engineering MSc

2021/2022 / 1st Semester

COURSE COMMUNICATION FOLDER

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

Course datasheet

Course Title: Seismic College **Instructor:** **Dr. Ernő Takács**, PhD, Department Head at the Faculty of Earth Science and Engineering, Chief Counsellor at the Mining and Geological Survey of Hungary	**Code:** MFGFT730029 **Responsible department/institute:** Department of Geophysics / Institute of Geophysics and Geoinformatics **Type of course:** Optional
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 a comprehensive knowledge on the seismic wave propagation, data processing, and interpretation. Students will get an overview about the acoustic and elastic rock properties and the different wave types (P- and S-waves) utilized in the seismic exploration. They will study the aims and effects of various reflection data processing steps and they will learn how to carry out a reliable AVO (Amplitude Versus Offset) data analysis for prediction of hydrocarbon bearing porous geological formations. A practical exercise on tutorial dataset will also be helpful to understand how to utilize Hampson-Russell AVO® software package.

Competencies to evolve:
Knowledge: T1, T2, T3, T4, T5, T6, T7, T8, T9
Ability: K1, K2, K3, K12, K13
Attitude: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Short curriculum of the subject:
Year to year selected special topics are offered for the students in the fields of seismic data processing and interpretation (e.g. Common Reflection Surface stacking, Amplitude Versus Offset analysis). The subject is also useful for the students to obtain a deep insight in the topic of their selected thesis work.

Assessment and grading:
Signature requirement: working out a specific seismic task with written report.
Grading limits:
> 80%: excellent,
70-79%: good,
60-69%: medium,
50-59%: satisfactory,
< 50%: unsatisfactory.

Compulsory or recommended literature:

Some related books:

1. Bacon, M., Simm, R., Redshaw, T.: 3-D Seismic Interpretation, 2003
2. Kearey, P., Brooks, M., Hill, I.: An Introduction to Geophysical Exploration, 2002
3. Serra, O.: Well Logging and Reservoir Evaluation, 2007
4. Sheriff, R.E., Geldart, L.P.: Exploration Seismology, 1995
5. Yilmaz, Ö.: Seismic Data Analysis: Processing, Inversion, and Interpretation, 2001

Some related papers:

1. Gúthy, T., Takács, E., Kovács, A.Cs., Fancsik, T., Csabafi, R., Török, I., Hegedűs, E. 2018: Recent developments in imaging the earth's crust by deep seismic data beneath the eastern parts of the Pannonian Basin, *Interpretation*, 6(1), p. SB23-SB35.
2. Hajnal, Z., Takács, E., Pandit, B., Annesley, I.R. 2015: Uranium mineralization indicators from seismic and well log data in the Shea Creek area at the southern margin of the Carswell Impact Structure, Athabasca Basin, Canada. *Geophysical Prospecting*, 63, p. 861-880.
3. Takács, E., Kummer, I., Sipos, J., Pápa, A. 2001: Bright spot analysis within the Pannonian Basin using horizon velocity estimation and Hilbert and AVO attributes, *First Break*, 17(3), 79-85.
4. Takács, E., Hajnal, Z., Pandit, B., Annesley, I.R. 2015: Mapping of alteration zones with seismic-amplitude data and well logs in the hard-rock environment of the Keefe Lake area, Athabasca Basin, Canada. *The Leading Edge*, 34, p. 530-538.

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

Syllabus of the semester

Week	Lecture
1	Geophysical methods in ore exploration - Athabasca Basin, Canada
2	Seismic methods in hydrocarbon exploration
3	Direct Hydrocarbon Indicators and AVO analysis
4	Structural investigation of the Darnó Shear Zone, NE Hungary
5	Types of elastic waves and wave propagation
6	Planning and implementation of seismic reflection surveys
7	Reflection data processing utilizing ProMAX® Part 1
8	Reflection data processing utilizing ProMAX® Part 2
9	No education
10	A new seismic stacking technique (Common Reflection Surface stacking)
11	Well logging methods and relation with the surface seismic data
12	Seismic interpretation utilizing Petrel®
13	Hydrocarbon prediction utilizing AVO® and STRATA®
14	Final discussion and conclusions

Week	Seminar
1	Geophysical exploration, data acquisition, data processing, interpretation, and prospecting
2	Theoretical and practical basics of the seismic methods and data processing
3	Direct Hydrocarbon Indicators and AVO analysis from theoretical and practical viewpoints (practical exercise utilizing AVO®)
4	What do the gravity, magnetic, and seismic data tell us about the structure of the geological formations and faults
5	Propagation of the different types of refracted, transmitted, and reflected P- and S-waves
6	How to design and carry out a successful seismic survey
7	Pre-stack seismic data processing steps in ProMAX®
8	Post-stack seismic data processing steps in ProMAX®
9	No education
10	Advantages of CRS stacking compared with the conventional CDP one
11	Petrophysical parameters obtained by well logging, the bridge between the borehole and surface seismic data (VSP and sonic logs)
12	Building geological-geophysical models (G&G) in Petrel®
13	Working with Hampson-Russell's AVO® and STRATA® to get Lame-parameters
14	How to prepare for the final examination

Some sample questions for the final exam with answers

1. How do you classify the seismic waves by their propagation and particle motion? What are most important petrophysical properties guiding them?

   Reflected, refracted, and transmitted waves, P- and S-waves. Velocity, density, compressibility, rigidity, and Poisson's ratio.

2. 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 on the survey area (e.g. agricultural work or traffic).

3. Describe a usual data processing sequence and explain the aims of the individual processing steps involved in it.

   Bandpass filtering, air and surface wave attenuation, AGC, deconvolution, refraction statics, automatic statics, velocity analysis, and NMO correction. CDP stacking, F-X decon, and migration. Their most important aims are to reduce the noises and enhance the signals.

4. List and explain the additional processing steps in case of CRS stacking. What are the advantages of a CRS stack against a CDP stack?

   CRS zero offset and dip search, CRS velocity precompute, CRS stacking. Higher quality images from complex and dipping geological structures.