EXPLORATION SEISMIC TECNIQUES AND INTERPRETATION

Petroleum Geoscience Engineers MSc course

2022/2023 2. Semester

COURSE COMMUNICATION FOLDER

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

Course datasheet

Course Title: Exploration seismic techniques and interpretation	**Credits: 4**

Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week:**lec. 2, sem. 2**

Neptun code: MFGFT720016

Type of Assessment (exam. / pr. mark. / other): exam

Attendance at lectures is regulated by the university code of education and examination. Writing two tests during the term and making one power point presentation on an assigned topic (condition of signature).

Grading limits:
>86%: excellent,
71-85%: good,
56-70%: satisfactory,
46-55%: pass,
<45%: fail.

Position in Curriculum (which semester): **second**

Pre-requisites *(if any)*:

Course Description: General planning of 2D and 3D seismic surveys for actual exploration targets. Quality control during data acquisition and data processing. Introduction to seismic data processing steps, parameter selections and creation of data processing flows. Introduction to seismic interpretation methods: structural and petrophysical interpretation.

Study goals:

The course provides an integrated introduction to the acquisition, processing and interpretation of 2-D and 3-D seismic data sets. The topic has a particularly strong practical emphasis, with many sessions conducted on an industry-standard computer workstation network.

Course content:

From planning phase of seismic data acquisition, state-of the art acquisition methods, up-to-date recording systems (cable and wireless systems), applicable seismic source types (vibroseis, impulse) and source related noises will be overviewed. Basic data processing steps are discussed with their effects to data quality improvement and signal to noise ratio enhancement. Typical 2-D and 3-D data processing flows are provided. Fundamentals of interpreting (correlation, sequence stratigraphy, 3-D visualization, amplitude studies, AVO, time sections, depth conversions, depth sections) will be discussed and demonstrated. Hands-on experience of interpreting 2-D and 3-D seismic datasets from a variety of structural and stratigraphic settings will be provided.

Education method: Electronic presentations by PC and projector. Software: OMNI, VISTA, Kingdom, Hampson-Russel and OpendTect systems installed on workstation.

Competencies to evolve:
T1, T3, T4, T5, T6, T12, K2, K3, K6, K7, A1

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

- W. Ashcroft, 2011: A Petroleum Geologist's Guide to Seismic Reflection.
- Öz Yilmaz, 2001: Seismic Data Analysis: Processing, Inversion, and Interpretation.
- M. Bacon, R. Simm, T. Redshaw, 2003: 3-D Seismic Interpretation.
- Gadallah, Mamdouh R, and Ray L Fisher. Exploration Geophysics. Berlin: Springer, 2009.
- Nanda, Niranjan C., 2016: Seismic Data Interpretation and Evaluation for Hydrocarbon Exploration and Production : a Practitioner's Guide.

Responsible Instructor (*name, position, scientific degree):*

László Gombár Dr., honorary assistant professor

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):
Dr. Ernő Takács and Márton Braun (SZTFH Faculty), Péter Zahuczky (MOL Group)

Syllabus of the semester

Date	Lecture
February 28	Planning 2D and 3D seismic surveys. Recording parameter selection depending on the actual target depth and geological, geophysical model
March 07	Seismic data acquisition systems. Cable connected and wireless telemetry recording systems, field quality control procedures, standard equipment tests; single sensor and geophone arrays; geophones and MEMS
March 14	Seismic Recording QC - industry specifications. 2D -3D seismic data acquisition planning and on-site QC with OMNI design software package (fold-, offset-, azimuth distribution control)
March 21	2D-3D seismic data processing– geometry checking, construction of basic processing flows
March 28	Introduction into seismic interpretation
April 04	Theoretical backgrounds of AVO data processing and interpretation. AVO attribute sections.
April 25	Seismic interpretation workstations: hardware and software. Introduction to SMT Kingdom interpretation workstation software
Mary 02	Reservoir prediction utilizing Hampson-Russel software
May 09	Seismic interpretation workstations: hardware and software. Introduction to SMT Kingdom interpretation workstation software
May 16	Seismic interpretation methods, structural and quantitative interpretation; characterization of seismic formations and seismic facies analyses
May 23	Practical aspects of Amplitude versus Offset (AVO) method; petrophysical and geophysical background and theory
May 30	AVO processing and interpretation in direct HC detection. Seismic modelling and generation of synthetic seismic data.

Date	Seminar

February 28	Seismic modelling, calculation of acoustic impedances as well as reflection and transmission coefficients for different horizontal layered models; Calculation of reflected signal amplitudes recorded at the surface
March 07	Analyses of seismic field records; determination of coherent noise parameters: apparent velocity, dominant frequency, wavelength; ground roll and other noise weave parameters; first arrival and refraction arrivals on the seismograms
March 14	Introduction to OMNI system; 2D and 3D seismic survey planning, on-site field quality control options.
March 21	Introduction to VISTA data processing system, generation of basic processing flows, checking the influence of the different processing parameters
March 28	Introduction to the interpretation workstation software Checking the influence of the different processing parameters, velocity analyses, NMO correction, CDP stacking with VISTA
April 04	Integrated interpretation of different geophysical (seismic and well(data, AVO interpretation,
April 25	Interpretation practice with Kingdom software: Seismic facies analyses, geology and reflection horizon interpretation Introduction to the interpretation workstation software
May 02	Interpretation practice with Hampson-Russel software package
May 09	Interpretation practice with OpendTect software: Structural interpretation, fault systems, erosional surfaces
May 16	Geological model building, development history determination on the basis of seismic section and well data
May 23	Edge model and seismic amplitude tuning, determination of seismic resolution with OpendTect V
May 30	Calculation of synthetic seismograms from acoustic- and density logs with OpendTect, AVO interpretation

Sample for exam questions

1. What are the main physical principles describing the elastic wave propagation at an interface between two layers having different seismic propagation velocity and density? Acoustic impedance, reflection and transmission coefficients at normal wave incidence at the interface.

2. Basic equation of the reflection arrival time-distance curve in case of horizontally layered medium. What types of waves are generated by source acting on the surface?

3. Basic types of seismic energy sources and their main features. Signal function of a vibroseis source in time – and in frequency domain in case of linear sweep. Main parameters of the sweep function.

4. The main physical effects responsible for amplitude decay of the seismic signal propagating through Z- distance from the source location.

5. Why do we record multichannel, multifold data in the field at reflection seismic surveys? The main parts of a telemetry seismic recording system and their functions in data acquisition process.

6. Applying dynamite source in the field, what are the main shooting parameters determining the signal amplitude and frequency band as well as the signal to noise ratio?

7. Applying vibroseis source in the field, what are the main source parameters determining the source signal energy and signal to noise ratio.

8. The main function of VSP and check-shot surveys. Types of VSP surveys. Which wave field is containing the reflection data?

9. Refraction wave generation criteria. Distance-arrival time function of refraction waves. Role of Low Velocity Layer (LVL) surveys. Shallow refraction and up-hole surveys.

10. Seismic channel convolution model in the presence of background noise. The role of amplitude corrections and deconvolution processing steps on a seismic channel.