EXPLORATION SEISMIC TECNIQUES AND INTERPRETATION

Petroleum Geoscience Engineers MSc course

2019/2020 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

Attendence at lectures is regulated by the university code of education and examination. Writing two tests during the term and making one powerpoint 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, Petrel, OpendTect system 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 Ágnes Cserkész-Nagy (Hungarian Mining and Geological Survey), Péter Zahuczky and István Sebe (MOL Group)

Syllabus of the semester

Week	Lecture
February 11	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, Source parameter selection tests
February 18	Planning 2D and 3D seismic surveys. Recording parameter selection depending on the actual target depth and geological, geophysical model 2D -3D seismic data acquisition planning and on-site QC with OMNI design software package (fold-, offset-, azimuth distribution control)
February 25	2D -3D seismic data processing workflows, 1D and 2D filtering, deconvolution, noise elimination, CDP stacking, static and dynamic correction calculation, post stack and pre-stack migration procedures to enhance seismic image of the subsurface
March 03	Amplitude versus Offset (AVO) methods - petrophysical and geophysical background, theory of the direct CH detection
March 10	Uranium exploration in Canada, presentation of complex geophysical exploration methods applied for uranium exploration
March 17	Geothermal exploration in the Pannonian Basin, geological model and applied geophysical methods
March 24	Unconventional CH deposits and their exploration methods Detection and characterization of the different unconventional reservoir types
March 31	Seismic facies analyses, geology and reflection horizon interpretation Introduction to application of Kingdom/Petrel seismic interpretation software
April 07	Interpretation methods with application of Kingdom/Petrel seismic software: Structural interpretation, picking reflection horizons
April 14	Interpretation with application of Kingdom/Petrel seismic software: quantitative interpretation; characterization of seismic formations and seismic facies analyses
April 21	Introduction into application of OpendTect seismic interpretation software: features and options for seismic data visualization
April 28	Application of OpendTect for AVO anomaly detection, theoretical background of synthetic seismic channel calculation, reservoir characterization

May 05	Application of OpendTect for 2D & 3D seismic interpretation, matching well logs to seismic sections, TWT –depth conversion using VSP and well log data
May 12	Geological model building, development history determination on the basis of seismic section and well data with OpendTect software

Week	**Seminar**
February 11	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
February 18	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
February 25	Application of OMNI 2D & 3D seismic design system; 2D and 3D seismic survey planning, on-site field quality control options, seismic data processing in practice
March 03	LVL calculation from shallow refraction field data: editing of the records, first break picking, time -distance curve determination
March 10	Velocity and depth calculations for different geological models
March 17	Basics of structural interpretation applied for geothermal reservoir delineation
March 24	Checking the influence of the different processing parameters, velocity analyses, NMO correction, CDP stacking
March 31	Interpretation practice with Kingdom software: Seismic facies analyses, geology and reflection horizon interpretation
April 07	Interpretation practice with Kingdom software: Structural interpretation, fault systems, erosional surfaces
April 14	Complex integrated interpretation of geophysical data: gravity, magnetic, MT, seismic and well data
April 21	Direct HC detecting methods in practice, AVO analyses options provided by OpendTect software
April 28	Edge model and seismic amplitude tuning, determination of seismic resolution with OpendTect
May 05	Calculation of synthetic seismograms from acoustic- and density logs with OpendTect

May 12	Geological model building, development history determination in practice with seismic section and well data using OpendTect software

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.