EXPLORATION SEISMIC TECHNIQUES AND INTERPRETATION

Petroleum Geoengineer MSc

2018/19 II. 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 will be discussed with their effects to data quality improvement and signal to noise ratio enhancement. Typical 2-D and 3-D data processing flows will be 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, 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):* **Tamás Fancsik Dr., associate professor, CSc.**	

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):
László Gombár Dr., engineer teacher,
István Sebe (MOL Group),
Attila Somfai (MOL Group),
Péter Zahuczki (MOL Group),
Ernő Takács Dr., (MBFSZ)

Syllabus of the semester

Week	Lecture
Febr. 13.	Planning 2D and 3D seismic surveys. Recording parameter selection depending on the actual target depth and geological, geophysical model
Febr. 20.	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
Febr. 27.	Seismic energy sources: impulsive and vibroseis source characterization, source parameters affecting signal energy, frequency content and signal to noise ratio
March 6.	Source parameter tests and recording parameter selection at start of a survey; standard vibrator and shooting system acceptance tests, industry specifications
March 13.	Enhanced seismic data acquisition technologies: flip-flop source, slip sweep method, HFVS (High Fidelity Vibrator System) Source generated coherent noises and their characters, methods for reducing ground roll and other noise waves; Cultural background noise (vehicle and urban noises) reduction techniques to improve signal to noise ratio
March 20.	Holiday.
March 27.	Low velocity layer (LVL) determination methods: up-hole measurements, shallow refraction survey; processing and interpretation of shallow refraction data, LVL model and static correction calculation
April 3.	VSP surveys (zero offset, offset and walk-away VSP surveys), data acquisition parameters, data processing; matching to seismic data, synthetic seismograms
April 10.	Seismic data processing for 2D and 3D; static and dynamic corrections, 1D and 2D filtering, deconvolution, noise elimination, CDP stacking and post stack and pre-stack migration procedures
April 17.	2D -3D seismic data acquisition planning and on-site QC with OMNI design software package (fold-, offset-, azimuth distribution control)
April 24.	2D-3D seismic data quality control and on-site data processing with VISTA software – geometry checking, construction of basic processing flows
May 1.	Holiday.
May 8.	Basics of Amplitude versus Offset (AVO) method; petrophysical and geophysical background and theory. AVO processing and interpretation
May 15.	Introduction to seismic interpretation methods, structural and quantitative interpretation; characterization of seismic formations and seismic facies analyses

Week	Seminar
Febr. 13.	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
Febr. 20.	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
Febr. 27.	Determination of the depth and velocity of the first consolidated layer below the source point from first arrivals with refraction method, calculation of depth and average velocity of a layer from reflection hyperbolas
March 6.	LVL calculation from shallow refraction field data: editing of the records, first break picking, time -distance curve determination, velocity and depth calculations for different near surface geological models
March 13.	Introduction to OMNI system; 2D and 3D seismic survey planing, on-site field quality control options. Introduction to VISTA data processing system, generation of basic processing flows, checking the influence of the different processing parameters
March 20.	Holiday.
March 27.	Checking the influence of the different processing parameters, velocity analyses, NMO correction, CDP stacking with VISTA
April 3.	Introduction to the direct HC detecting methods, AVO analyses with OpendTect software
April 10.	Edge model and seismic amplitude tuning, determination of seismic resolution with OpendTect
April 17.	Calculation of synthetic seismograms from acoustic- and density logs with OpendTect
April 24.	Interpretation practice with Kingdom software: Seismic facies analyses, geology and reflection horizon interpretation, structural interpretation, fault systems, erosional surfaces
May 1.	Holiday.
May 8.	Geological model building, development history determination on the basis of seismic section and well data
May 15.	Complex integrated interpretation of geophysical data: gravity, magnetic, MT, seismic and well data

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.