BASIN MODELING

Petroleum Geoscience MSc course

2018/19 2. Semester

COURSE COMMICATION FOLDER

University of Miskolc

Faculty of Earth Science and Engineering

Institute of Mineralogy and Geology

Course datasheet

Course Title: Basin modeling	**Credits: 4**
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **lec. 2, sem. 2**	
Neptun code: MFFAT720011	
Type of Assessment(exam. / pr. mark. / other):**pr. mark** Exercise: solving a task in basin modelling process using the tools and software introduced during the course. **Grading limits:** >80%: excellent, 70-79.9%: good, 60-69.9%: medium, 50-59.9%: satisfactory, <50%: unsatisfactory.	
Position in Curriculum (which semester): **second**	
Pre-requisites *(if any)*:	
Course Description:	
Acquired store of learning: Study goals:The course covers the fundamentals of petroleum systems analysis and its use in hydrocarbon exploration. The topic includes concepts and examples of petroleum systems, petroleum source rocks, modelling of petroleum systems, and an introduction to basin-scale pressures and fluid dynamics. Practical examples in using the quantitative tools and techniques in modeling petroleum systems of a basin (i.e. the formation, generation, migration and trapping of hydrocarbons) are provided. At the end of the topic, students are able to undertake 1-D basin modelling using industry-standard software, and are aware of the extension of this process into 2-D and 3-D applications. Examples from different basin types are used to illustrate the petroleum systems concept. Course content:Basic principles of sedimentology (grain size, bedding, transport capacity, sedimentation rate and preservation potential). The main types of basins, and their most important features. The geodynamical characterization and geothermic properties of the main basin types. The tectonic and paleoenvironmental recontstruction. Facies models in siliciclastic marine and fluvial systems. Facies analysis in outcrops, cores and wireline logs. Concept and way of high resolution facies correlation on wireline logs in marine successions: „parasequences", sets of „parasequences", correlative surfaces like flooding surface (FS), maximum flooding surface (MFS). The sequence stratigraphic approach: the accommodation concept, systems tracts (Lowstand, Transgressive, Highstand and Falling Stage Systems Tract), the problems of the sequence boundary (SB). Sequences on wireline logs and seismic profiles (migrated time sections). Problems and possibilities of terrestrial (fluvial) sequences. Carbonate depositional environments, analogies and	

differences. Variations in sequence evolution in response to the relative sea level changes (eustatic, tectonic and climatic controls) and to the basin structure development. 2-D, 3-D and 4-D problems and solutions in basin analysis.Practical course: Method of facies description/documentation on outcrops (Diósgyőr sand pit). Handling and facies interpretation of log data. Appearance of sedimentary features on cores and wireline logs (Geokomplex Ltd. - Miskolc). Log facies analysis and log correlations in datum- and sea-level-projected circumstances. Relation of wireline logs and seismic data in sequence stratigraphic context, joint interpretation of log facies and seismic horizons. Sequence stratigraphic interpretations of seismic sections and log correlations. Identifications of structural elements on seismic sections from the aspect of sequence development.

Education method:Lectures with presentation slides, exercises on sheets and with computer.

Competencies to evolve:

T1, T4, T5, T6, T10, T11, T12, K2, K4, K5, K6, K8, K10, A1

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

- Bridge, J.S. 2003, Rivers and Floodplains, Blackwell Publishing p. 491.
- Magyar I. 2010, A Pannon-medence ősföldrajza és környezeti viszonyai a késő miocénben. – GeoLitera, Szeged, p. 139.
- Posamentier H.W., Allen G.P. 1999, Siliciclastic Sequence Stratigraphy – Concepts and Applications – SEPM No. 7 204 p.
- Püspöki, Z. Torma, B. (eds.) (2010): Fluvial sediments in cores and geophysical well-logs. – Dominium Publisher, p. 327.
- Van Wagoner, J.C., Mitchum, R.M.Jr., Campion, K.M., Rahmanian, V.D. 1990, Siliciclastic sequence stratigraphy in well logs, core and outcrops: concepts for high-resolution correlation of time and facies. AAPG Methods in Exploration Series, v. 7, p. 55.

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

Viktor Mádai Dr., associate professor, PhD

Other Faculty Member(s) Involved in Teaching, if any (*name, position, scientific degree*):

Katalin Milota Dr., PhD (MOL Group)

Zoltán Püspöki Dr., PhD (Geological and Geophysical Institute of Hungary)

TANTÁRGYTEMATIKA
2018/19/II., csütörtök, 8-12

Date	Lecture	Practical
2019.02.14.	Basin modeling and basin analysis, Basin classification, plate tectonics, basin-forming mechanism	Introduction to Basin Modeling History, Geological processes, Structure of a model, Petroleum system modeling, Modeling workflows, Structural restoration, Comparison with reservoir modeling
2019.02.21.	The physical state of litosphere, Stress and strain, Heat flow, conduction, convection, Gravity and isostasy, Rock rheology. Rift, oceans, Rift-relatedstructures; Examples for structural characterisation of rifts–seismic sections	Pore Pressure, Compaction and Tectonics: Bulk Stresses Pore Pressure Formation and Fluid Flow Compaction and Porosity Reduction . Terzaghi Type Models Basic Formulation Mechanical Compaction, Permeability and Viscosity 1D Pressure Solutions, Pressure Solutions in 2D and 3D,
2019.02.28.	Extensional structures; Continental rifts; Low-angle normal faults, Metarmophic core complexes;	Special Processes of Pressure Formation, Chemical Compaction, Fluid Expansion Models, Overpressure Calibration , Geomechanical Models, Stress and Deformation, Failure Analysis, Faults, Paleo–Models, Event–Stepping, Paleo–Stepping, Overthrusting
2019.03.07.	Oceanic curst formation; -hiperextended margins, -Exhumation of mantle litosphere	Heat Flow Analysis: One Dimensional (1D) Models, Steady State Models, Transient Effect, Thermal Conductivity, Rock and Mineral Functions, Pore Fluid Functions, Specific Heat Capacity, Rock and Mineral Functions, Pore Fluid Functions, Radiogenic Heat, Three Dimensional, Heat Flow Equation, Heat Convection,
2019.03.14.	Basins due to Flexure: Litospheric flexure, Geometry of Deflection, Flexural Rigidity of Oceanic and Continental Litosphere, Orogenic Wedges.	Magmatic Intrusions, Permafrost, SWI Temperatures, Crustal Models for Basal Heat Flow Prediction, The Principle of Isostasy, Heat Flow Models, Workflow Crustal Preprocessing, Heat Flow Calibration, Example Workflow for 3D Heat Calibration,
2019.03.21.	Effects of mantle dynamics: , Dynamic topography	Petroleum Generation: Distributed Reactivity Kinetics, Petroleum Generation Kinetics, Bulk Kinetics, Oil–Gas Kinetics, Compositional Kinetics, Thermal Calibration Parameters, Vitrinite Reflectance,
2019.03.28.	Basins, associated with strike-slip deformation: The structural pattern of strike- slip fault systems, Basins in strike-slip zones.	Molecular Biomarkers, *T*max Values, Isotopic Fractionation, Fission–Track Analysis, Adsorption, Biodegradation, Source Rock Analysis,

2019.04.04.	Salt properties and rheology; Salt diapirism, salt geometry and the flow of salt; Rising diapirs: processes; Salt diapirism in the extensional regime;	Fluid Analysis: Water Phase, Binary Mixtures and Black Oil Models, Equations of State (EOS), Mixing Rules, Phase Equilibrium, Flash Calculations,
2019.04.11.	Diapirism in the contractional regime; Salt collapse by carstification; Salt décollements;	Classification of Petroleum, PT–Paths, Property Prediction, Density, Bubble Point Pressure, Gas Oil Ratio (GOR), Oil Formation Volume Factor *Bo,* Viscosity, Interfacial Tension (IFT), Calibration of a Fluid Model, Calibration and Fluid Heavy End, Tuning of Pseudo–Component Parameters, Tuning of the Binary Interaction Parameter (BIP), Gas Hydrates,
2019.04.18.	Contractional structures; Inversion of rifts; Foreland basins;-Types -Examples	Migration and Accumulation: Geological Background, Multi–Phase Darcy Flow, Capillary Pressure, Pressure at Phase Boundaries, Three Phase Flow Formulation without Phase Changes, Multicomponent Flow Equations with Phase Changes, Black Oil Model, Diffusion, Reservoirs, Flowpath Analysis, Drainage Area Analysis, Accumulation Analysis, Faults and Small Scale Features, Overpressure and Waterflow, Non–Ideal Reservoirs, Hybrid Method, Domain Decomposition, Break Through, Fault Flow,
2019.04.25.	The sediment routing system, Weathering, Terrestial sedimentand solute yields, Erosion rates.	Flowpath Modeling, Invasion Percolation, Physical Background, Percolation on Microscopic Length Scales, Upscaling of Microscopic Percolation, One Phase Invasion Percolation,
2019.05.02.	Basin stratigraphy, Stratigraphic cycles, Driving mechanisms, Numerical simulations of stratygraphic processes.	Two Phase Migration with Displacement, Discretization of Space and Property Assignment, Anisotropy, Discussion, Mass Balances, Fundamental Laws of Mass Conservation, The Petroleum System Reservoir Structures and Accumulations,
2019.05.09.	Subsidence and thermal history, porosity during subsidence, Backstripping, Thermal history, Geothermal and palogeothermal history of basins.	Risk Analysis: Monte Carlo Simulation, Uncertainty Distributions, Derived Uncertainty Parameters, Latin Hypercube Sampling (LHC), Uncertainty Correlations, Analysis of Results, Model Data, Bayesian Approach, Prior Information of Derived Parameters,
2019.05.16.	The petroleum play, The petroleum system and play concept, the petroleum charge system, The	Correlations of Priors, Prior Information of Nominal Uncertainties, Deterministic Sampling, Cubical Design, Other

	reservoire, Regional topseal, The trap.	Deterministic Designs, Metamodels, Response Surfaces, Fast Thermal Simulation, Kriging, Neural Networks, Other Methods for Metamodeling, Calibration with Markov Chain Monte Carlo Series.

MINTAZÁRTHELYI

What is the meaning of the Petroleum System? Define its elements and processes! (20%)

What is the difference between the effective source rock and the potential source rock (10%)?

What kind of parameters qualify a source rock (10%)?

Define the liptinite, vitrinite and the inertinite! (10%)

What is the vitrinite? And what gives its significance? (10%)

What can be the definition of a sedimentary basin? (10%)

What can be the basis of classification of sedimentary basins? (10%)

List some of the characteristics of continental rift basins? (crust, lithosphere structure, geometry, faults, heat flow, initiation from, evolution toward?) Do not enter in details, but pick up main points (20%)

HALF TERM BASIN MODELING TASK

Prepare a 1D modeling task from a given layer structure. A well log, a facies schema, the place of the well (coordinates) and vitrinite and thermal data for callibration are in electronic form. Making an alone self study about the geology of the examinated area, write a complete geologic report about the preparaton, and results of the model and the literature data about the area.

6. EGYÉB KÖVETELMÉNYEK

During the writing of tests the usage of mobile phones are forbidden.

Miskolc, 2018. június 14.

Dr. Mádai Viktor
Tantárgyjegyző, egyetemi docens