



Basin modeling

Petroleum Geoscience MSc képzés
(nappali munkarendben)

TANTÁRGYI KOMMUNIKÁCIÓS DOSSZIÉ

**MISKOLCI EGYETEM
MŰSZAKI FÖLDTUDOMÁNYI KAR
ÁSVÁNYTANI FÖLDTANI INTÉZET**

Miskolc, 2022/23. II. félév

Tartalomjegyzék

1. Tantárgyleírás, tárgyjegyző, óraszám, kreditérték
2. Tantárgytematika (óraóra lebontva)
3. Minta zárthelyi
4. Féléves beadandó feladat Basin Modeling tárgykörében
5. Egyéb követelmények

Tantárgy neve: Basin Modeling	Tantárgy kódja: MFFAT720011 Tárgyfelelős tanszék/intézet: Ásvány- és Kőzettani Intézeti Tanszék
Tárgyfelelős: Viktor Má dai, Dr , PhD (Associated Professor) Előadást tartó oktató: László Fodor, Dr DSc Scientific Advisor Gyakorlatokat szervező oktató: Viktor Má dai, Dr , PhD (Associated Professor) Gyakorlatokat tartó oktató(k): Katalin Milota Dr., PhD (MOL Group), Viktor Má dai, Dr , PhD (Associated Professor)	Tantárgyelem: K
Javasolt félév: 3	Előfeltételek:
Óraszám/hét (ea+gyak): 2+2	Számonkérés módja (a/gy/v): pr. mark
Kreditpont: 4	Tagozat: nappali
Fejlesztendő kompetenciák: <i>tudás:</i> T1, T4, T5, T6, T10, T11, T12 <i>képesség:</i> K2, K4, K5, K6, K8, K10 <i>attitűd:</i> A1, <i>autonómia és felelősség:</i>	

Tantárgy feladata és célja: 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.

A tantárgy tematikus leírása: 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 reconstruction. 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.

A kurzusra jelentkezés módja: during the registration week, through NEPTUN system.

A tantárgy felvételének előfeltétele:

Oktatási módszer: Lectures from the theoretical material, and practices

Félévközi számonkérés módja, követelmények: Two tests in the 7th and 13th week. In the case of failed test (any of them), there is a third occasion in the 14th week.

Az aláírás feltételei a félév során:

Handing in the half year task in an acceptable format and level in time (last week of the semester), writing two tests at least on the minimum level of 51%. Failed tests are rewritable on the last week of the semester. Attendance of lectures and seminars are compulsory. Missing more than three occasions from lectures or seminars cause deny of signature.

A tantárgy lezárásának módja: signature + practice mark

Értékelés, a félévi érdemjegy számítása:

The evaluation is made in 50% by the solution of half year task. and 50% by the two tests.

Gyakorlati jegy: >80%: excellent, 70-79.9%: good, 60-69.9%: medium, 50-59.9%: satisfactory, <50%: unsatisfactory.

Oktatási segédeszközök

Black board, choke, PC and projector . Course book: *Fossen H. Structural Geology*, Cambridge University Press (2011)

Kötelező irodalom jegyzéke:

D.H. Welte B. Horsfield D.R. Baker (Eds.): Petroleum and Basin Evolution Insights from Petroleum Geochemistry, Geology and Basin Modeling, Springer-Verlag Berlin Heidelberg (1997)

Philip A. Allen, John R. Allen: Basin Analysis: Principles and Application to Petroleum Play Assessment, 3rd Edition., Wiley-Blackwell, 2013,

Hantschel T., Kauerauf A., I: Fundamentals of Basin and Petroleum Systems Modeling Springer (2009)

Bridge, J.S. Rivers and Floodplains, Blackwell Publishing 2003,

Javasolt irodalom:

Magyar I., A Pannon-medence ősföldrajza és környezeti viszonyai a késő miocénben. – GeoLitera, Szeged, 2010,

Posamentier H.W., Allen G.P. Siliciclastic Sequence Stratigraphy – Concepts and Applications – SEPM No. 7 1999,

Püspöki, Z. Torma, B. (eds.): Fluvial sediments in cores and geophysical well-logs. – Dominium Publisher, 2010,

Van Wagoner, J.C., Mitchum, R.M.Jr., Campion, K.M., Rahmanian, V.D. 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 1990,

2. TANTÁRGYTEMATIKA

Basin modeling

Tantárgytematika (ÜTEMTERV)

tavaszi félév

PGE MSc képzés

törzsanyag tárgya

Előadás:

- 1. hét:** Basin modeling and basin analysis, Basin classification, plate tectonics, basin-forming mechanism,
- 2. hét:** The physical state of lithosphere, Stress and strain, Heat flow, conduction, convection, Gravity and isostasy, Rock rheology.
hét: Rift, oceans, Rift-related structures; Examples for structural characterisation of rifts—seismic sections
- 3. hét:** Extensional structures; Continental rifts; Low-angle normal faults, Metamorphic core complexes;
- 4. hét:** Oceanic crust formation; -hiperextended margins, -Exhumation of mantle lithosphere
- 5. hét:** Basins due to Flexure: Lithospheric flexure, Geometry of Deflection, Flexural Rigidity of Oceanic and Continental Lithosphere, Orogenic Wedges.
- 6. hét:** Effects of mantle dynamics: , Dynamic topography
- 7. hét:** Basins, associated with strike-slip deformation: The structural pattern of strike-slip fault systems, Basins in strike-slip zones.
- 8. hét:** Salt properties and rheology; Salt diapirism, salt geometry and the flow of salt; Rising diapirs: processes; Salt diapirism in the extensional regime;
- 9. hét:** Diapirism in the contractional regime; Salt collapse by carstification; Salt décollements;
- 10. hét:** Contractional structures; Inversion of rifts; Foreland basins;-Types -Examples
- 11. hét:** The sediment routing system, Weathering, Terrestrial sediment and solute yields, Erosion rates.

12. hét: Basin stratigraphy, Stratigraphic cycles, Driving mechanisms, Numerical simulations of stratigraphic processes.

13. hét: Subsidence and thermal history, porosity during subsidence, Backstripping, Thermal history, Geothermal and palogeothermal history of basins.

14. hét: The petroleum play, The petroleum system and play concept, the petroleum charge system, The reservoir, Regional topseal, The trap.

Gyakorlat:

1. hét: Introduction to Basin Modeling History, Geological processes, Structure of a model, Petroleum system modeling, Modeling workflows, Structural restoration, Comparison with reservoir modeling

2. hét: 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,

3. hét: 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

4. hét: 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,

5. hét: 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,

6.hét: Petroleum Generation: Distributed Reactivity Kinetics, Petroleum Generation Kinetics, Bulk Kinetics, Oil–Gas Kinetics, Compositional Kinetics, Thermal Calibration Parameters, Vitrinite Reflectance,

7. hét: Molecular Biomarkers, Tmax Values, Isotopic Fractionation, Fission–Track Analysis, Adsorption, Biodegradation, Source Rock Analysis,

8. hét: Fluid Analysis: Water Phase, Binary Mixtures and Black Oil Models, Equations of State (EOS), Mixing Rules, Phase Equilibrium, Flash Calculations,

9. hét: Classification of Petroleum, PT-Paths, Property Prediction, Density, Bubble Point Pressure, Gas Oil Ratio (GOR), Oil Formation Volume Factor B_o , 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,

10. hét: 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,

11. hét: Flowpath Modeling, Invasion Percolation, Physical Background, Percolation on Microscopic Length Scales, Upscaling of Microscopic Percolation, One Phase Invasion Percolation, 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,

13. hét: 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,

14. hét: Correlations of Priors, Prior Information of Nominal Uncertainties, Deterministic Sampling, Cubical Design, Other Deterministic Designs, Metamodels, Response Surfaces, Fast Thermal Simulation, Kriging, Neural Networks, Other Methods for Metamodeling, Calibration with Markov Chain Monte Carlo Series.

3. 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%)

4. 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 calibration are in electronic form. Making an alone self study about the geology of the examined area, write a complete geologic report about the preparation, 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, 2023. január 16.

Dr. Máдай Viktor

Tantárgyjegyző, egyetemi docens