HYDROCARBON GEOLOGY

Earth Sciences Engineering MSc

MFFAT720029

2018/19 II. semester

COURSE COMMUNICATION FOLDER

University of Miskolc
Faculty of Earth Science and Engineering
Institute of Mineralogy and Geology

Course datasheet

Course Title: Hydrocarbon geology **Responsible Instructor:** Dr. Velledits Felictiász	**Neptun code:** MFFAT720029 **Responsible Department:** Dpt. of Mineralogy and Geology **Type of course: C**
Position in Curriculum (which semester): **second**	**Pre-requisites:** Physical geology (MFFTT 710001)
Type (lec. / sem. / lab. / consult.) and Number of Contact Hours per Week: **lec. 2, lab. 0**	**Type of Assessment** (exam. / pr. mark. / other): **exam**
Credits: 2	**Course:** full-time

Study goals:

Introduce students

- the basic concepts of hydrocarbone geology
- the geological exploration and interpretation methods in the value chain of crude oil and gas exploration, field development and production
- the steps needed to solve the basic hydrocarbone geological tasks.

Competencies to evolve:

knowledge: T1, T2, T3, T4, T5, T7, T8, T9
skills: K1, K2, K3, K5, K6, K7, K9, K11, K12, K13
attitude: A1, A2, A3, A4, A5, A7
autonomy and responsibility: F1, F2, F3, F4, F5

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

Grading limits:
>80%: excellent,
70-79%: good,
60-69%: medium,
50-59%: satisfactory,
<50%: unsatisfactory

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

BércziI.: Petroleum Geology, (Jegyzet, 1988, Montanuniversität Leoben)
BércziI.: Development Geology (Jegyzet, 2003, HOT Engineering&Shell Iran Offshore)
University of Texas: Petroleum Geology & Reservoirs, www.utexas.edu/ce/petex/aids/pubs/petroleum-geology
Mike Sherherd (2009): Oil Field Production Geology. AAPG Memoir 91. 1-360.
Bjorlykke K. (2010): Petroleum Geoscience: From Sedimentary Environments to Rock Physics. Springer.
Hyne N. J. (2001): Nontechnical Guide to Petroleum Geology, Exploration, drilling, and Production. 1-598. PennWell Corporation.
Slatt R.M. (2009): Stratigraphic Reservopir Characterization for petroleum Geologists, Geophysicists and Engineers. 1-478. Elsevier.
Carbonate reservoirs:
Wayne M. Ahr (2008) Geology of Carbonate Reservoirs. 277. Wiley Publication
Lucia (1999, 2007): Carbonte Reservoir Characterization. 226. Springer

Syllabus of the semester

Hydrocarbon geology
Wednesday, 12:00 – 14:00

Week	**Thematics of lecture**
2019.02.13.	the basic concepts of hydrocarbone geology
2019.02.20.	the geological exploration and interpretation methods in the value chain of crude oil and gas exploration, field development and production
2019.02.27.	the geological exploration and interpretation methods in the value chain of crude oil and gas exploration, field development and production
2019.03.06.	the geological exploration and interpretation methods in the value chain of crude oil and gas exploration, field development and production
2019.03.13.	the geological exploration and interpretation methods in the value chain of crude oil and gas exploration, field development and production
2019.03.20.	the geological exploration and interpretation methods in the value chain of crude oil and gas exploration, field development and production
2019.03.27.	the geological exploration and interpretation methods in the value chain of crude oil and gas exploration, field development and production
2019.04.03.	the geological exploration and interpretation methods in the value chain of crude oil and gas exploration, field development and production
2019.04.10.	Holiday
2019.04.17.	Holiday
2019.04.24.	the steps needed to solve the basic hydrocarbone geological tasks
2019.05.01.	Holiday
2019.05.08.	the steps needed to solve the basic hydrocarbone geological tasks
2019.05.15.	the steps needed to solve the basic hydrocarbone geological tasks

Midterm exam

1. What kind of sciences do we use in petroleum exploration?

Sedimentary geology, Micropaleontology, Organic geochemistry, Tectonics and structural geology, Seismic methods, Well-logging

(max: 10)

2. Describe the five requirements (Magic fives) that lead to accumulation of oil and gas!

In the case of a successful exploration: all five factors have to come together and in the correct sequence. If one fails, than we cannot expect there to be any oil or gas.

1. Source rock: Shale or very fine grained limestone, with a minimum of 0,5 % of organic matter.
2. Heat: Obtained from the Earth by burial of the source rock.

Oil window: oil generation: between 60 - 120 °C

Gas window: 120 - 225 ° C.

Above 225 ° C, the kerogen is inert, having expelled all hydrocarbons; only carbon remains as graphite

3. Reservoir**:** A layer or formation of rock that is both porous and permeable, usually sandstone of limestone.
4. Cap rock or seal: an impermeable layer above the reservoir to retain the petroleum within it, usually a shale or evaporite
5. Trap a subsurface environment, formed by structural or stratigraphic control, where the petroleum is barred from migration.

The trap must have been there before the oil/gas migration.

The petroleum must be preserved in the trap. Later tiltig or faultig could allow it to escape.

Further deep burial can lead to petroleum destruction.

(max: 10)

3. What are logs used for?

- for stratigraphic correlation (one well with the other)
- identification of sedimentary facies (only for siliciclastic sediments)
- identification of lithology
- to determine porosity
- to determine water and oil saturation
- to determine oil/water contact
- correlating sequences in sedimentary basin
- evaluating the properties of reservoir rocks and their fluid content for production purposes
- image logs: stratification, faults
- dip log: dips of layers

(max: 10)

5. What is source rock? Which rocks are the best source rocks?

Source rock is a rock that forms gas or oil.

The source of gas or oil is organic matter preserved in sedimentary rocks.

The sediment consists of 1) inorganic mineral grains, (sand, mud) 2) organic matter (dead animals and plants) are mixed. One part of the organic matter is lost by oxidation (from the air, out of the water).

Other part is preserved if

1) it was rapidly buried by other sediments

2) it was deposited under stagnant, anoxic conditions

The black colour of sedimentary rocks comes from the organic material

Source rocks are shales (black shales), some carbonates, marl and coal.

If the sorce rock is heated sufficiently (subsided), than it will generate oil or gas.

Typical source rocks, usually shales or limestones, contain about 1% organic matter and at least 0.5% total organic carbon (TOC), although a rich source rock might have as much as 10% organic matter.

Rocks of marine origin tend to be oil-prone, whereas terrestrial source rocks (such as coal) tend to be gas-prone.

(max: 10)

6. Why is migration necessary? What kind of migration do you know?

Newly generated HC is too dispersed (in the form of small droplets) in the source rocks. Source rock is too compact, has no permeablity. CH can’t be produced from the source rocks. **Migration**: hydrocarbonte migrates form the source rock through carrier rock into reservoir rock. CH concentrates in a rock with high porosity and permeability (reservoir rock) from which CH is extractable.

Types of migration
- ***Primary migration:*** expulsion from the fine-grained source rock
- ***Secondary migration:*** movement in carrier beds
- ***Tertiary migration:*** movement of a previously formed oil and gas accumulation.
(max: 10)

7. Define porosity! What kind of porosity do you know?

Porosity: is the ratio of void space in a rock to total volume of rock, and reflects the fluid storage capacity of the reservoir.

Φ=volume of void space/total volume of rock x 100

Primary porosity: amount of pore space present in the sediment at the time of deposition, formed during sedimentation.
Secondary porosity: post depositional porosity. Such porosity results from groundwater dissolution, recrytallization and fracturing.
Effective porosity: is the interconnected pore volume available to free fluids.
Total porosity: all void space in a rock and matrix whether effective, or none effective
Fracture porosity: the openings are produced by breaking the rocks
(max: 10)

8. What is wettability?

Wettability is the tendency for one fluid to be better attracted to a solid surface, than the other fluid. Wettability is a surface effect. The fluid that occupies the outside of the pore and is in contact with the rock surface is called the *wetting fluid*.
Where a reservoir rock is *water wet*, the water forms a thin film over most of the grain surfaces and will also fill the smaller pores. The oil or gas will occupy the remaining, more central volume of the pore system.
Conversely, in a reservoir that is *oil wet*, it is the oil that covers the grain surface and occupies the smaller pores; the water is located centrally within the pore structure
Sandstones are water-wet, carbonate are oil-wet or intermediate-wet.
(max: 10)

9. What is dry gas, and wet gas?

Dry gas: it is a gas under both subsurface reservoir and surface condition. Pure methane (CH_4 gas).
Wet gas: a liquid condensate separates from the gas after production under surface conditions but not in the reservoir. Contains less methane (typically less than 85% methane) and more ethane and other more complex hydrocarbons.
(max: 10)

10. What is dry gas, and wet gas?

Absolute permeability:
The permeability, when a single fluid or phase is present in the rock.
Relative permeability
When more than one fluid phase is present, the permeability of one phase is reduced by the presence of the other phases within the pore system.
The greater the water saturation the less permeable the reservoir will be to oil and gas.
Relative permeability curves display these relationships.