APPLIED GEOLOGY

(*Petroleum Engineering MSc*)
2020/21 I. semester

COURSE COMMUNICATION FOLDER

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

Course Title: Applied Geology **Instructor:** Velledits Felicitász	**Code:** MFFTT710003 **Responsible department/institute: MFFTT**
Position in curriculum (which semester): 1	**Pre-requisites (if any):** Basic geological knowledge
No. of contact hours per week (lecture + seminar): 2+1	**Type of Assessment (examination/ practical mark / other):** examination
Credits: 3	**Course:** full time

Study goals To acquaint students with geological and geophysical knowledge that is essential for hydrocarbon exploration. To familiarize the sedimentary rocks, which can serve as source rocks, reservoir rocks or seals. The show the relationship between hydrocarbon generation, migration and trapping. To highlight the close connection between sedimentation and reservoir productivity.

Compatencies to evolve:

Knowledge**:** T2, T6, T8, T10

Ability**:** K2, K8, K10, K11

Attitude: A2, A4, A7

Autonomy and responsibility: F1, F2, F4, F6, F7**:** F2, F4

Course Description:

01 Relationship of petroleum geology to science
02 Rock types, Sedimentary rocks
03 Stratigraphy
04 Plate tectonic and reservoirs
05 Petroleum system, The nature and formation of hydrocarbon
07 Migration, Source rocks
08 Reservoir Seal
09 Traps
10 Fluvial deposits and reservoirs
11 Aeolian sediments and reservoirs
12 Carbonate reservoir, Differences between carbonate and siliciclastic reservoirs
13. Unconventional hydrocarbons 1: Shale gas, Oil shale
14. Unconventional hydrocarbons 2: Oil sand, Gas hydrates, Coalbed methane

Assessment:

two written exam: Midterm exam, and Final exam. In both exam must be reached 59%.

Grading scale:

% value	Grade
90 -100%	5 (excellent)
80 – 89%	4 (good)
70 - 79%	3 (satisfactory)
60 - 69%	2 (pass)
0 - 59%	1 (failed)

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Compulsory or recommended literature resources:

- Stoneley, R.: Introduction to Petroleum Exploration for Non-geologists. OxfordUniversity Press, 1995, ISBN 0 19 854856 7
- Landes, K. K.: Petroleum Geology. John Wiley & Sons, 1959
- Pápay, J.: Development of Petroleum Reservoirs. Akadémiai Kiadó, 2003, ISBN 963 05 7927 8
- Selley, R., Sonnenberg, S.: Elements of Petroleum Geology 3rd edition, Elsevier, 2014., Hardcover ISBN: 9780123860316
- Bjorlykke, K.: Sedimentology and Petroleum Geology, Springer Verlag, 1989., ISBN: 978-3540176916

Féléves órabeosztás
08.09-2020 – 08.12.2020

08.09. 2020: Drop off
15.09. 2020: Drilling, Coring
22.09. 2020: Rock types, Sedimentary rocks
29.09. 2020: Stratigraphy
06.10. 2020: Plate tectonic and reservoirs
13.10. 2020. Petroleum system
20.10. 2020: Drop off
27. 10. 2020: Test
03.11. 2020: Reservoir characterisation, Generation of oil and gas
10.11. 2020: Migration, Source rocks
17.11. 2020: Traps, Fluvial deposits and reservoirs
24. 11. 2019. Carbonate reservoir, Differences between carbonate and siliciclastic reservoirs
01.12. 2020: Unconventional hydrocarbons 1: Shale gas, Oil shale, : Oil sand, Gas hydrates, Coalbed methane.
08. 12. 2020. Written exam.

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

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.

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

4. Why do extensional regimes provide good conditions for petroleum generation?

Extensional regimes have undergone crustal thinning and *subsidence*, which involves all the processes essential for petroleum to be *generated, trapped and accumulated* in sufficient volumes and concentrations for petroleum fields to be commercially interesting. Accordingly, such settings frequently display an *attractive combination* and distribution of source, reservoir and cap rocks, structural and stratigraphic traps and the conditions for maturation, expulsion, migration and accumulation of hydrocarbons.

Favourable conditions for petroleum generation

Crustal thinning: high heat flow, high geothermal gradients

Crustal thinning: Narrow, elongate, restricted basins

Volcanoes disappeared, but during fractures volcanic material effusions from below providing mineral nutrients for marine life. Rich source rocks

Favorable place for corals. Good reservoirs

If the sea is restricted, evaporites can be formed Good cap rock

Rift basins formed in areas with wet climates will be occupied by large lakes. Lacustrine basins often have an even better potential for producing source rocks than marine rift basins, because water stratification (density stratification) is usually more marked in lakes. We will therefore often find black, organic-rich shales in these lake basins.

Rift basins formed in arid zones are characterised by evaporite deposits. Block faulting will readily lead to isolated basins which are cut off with the open sea.

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.

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

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

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.

Miskolc, 2020. szeptember 7.

Dr. Velledits Felicitász
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