**ES486 Petroleum Geology – Cyber Thursday Out-of-Class Assignment February 21, 2019**

***Assignment Due for Hard Copy Submission in Class on Tuesday February 26, 2019***

Instructions: the ES486 team will be engaging in an online course in Petroleum Geology sponsored by Delft University of Technology, Netherlands. The goal will be to attend a video lecture and answer take-home video review questions, in addition to augment the assignment with a reading from our Selley Textbook, Chapter 5 (Generation and Migration of Petroluem) available on the ES486 Moodle Site.

**Part 1. Online Video Lecture Review**

Delft University of Technology

Open Source Online Course in Petroleum Geology

Unit 4 – Migration from Source to Reservoir – Overview

Web URL: <https://ocw.tudelft.nl/course-lectures/pgeo-l4-migration-source-reservoir/>

Oil results from kerogen, which in turn comes from organic matter, through a process of burial and thermal maturation over geologic time. This oil is then present in source rocks. The source rocks get over-pressured and oil moves from the source rocks to the reservoir rocks. Reservoir rocks can be imaged with seismic by geophysicists, and this is also where humans get the oil from. Here it is explained why migration happens, and some evidence of seepages which prove migration is given.

Primary migration is the migration from the source rock to ‘something else’, which is badly understood in science. The contradiction on pore sizes in source rocks and the sizes of the migrating molecules is explained. Moreover four possible primary migration mechanisms are discussed. Secondary migration is the migration from ‘something else’ to the reservoir rock. This is much better understood than primary migration. Buoyancy resulting from density differences is the driving force. Some migration pathways are presented, and seals which finally stop the migration are explained. The lecture is ended with a summary.

The recorded lecture covers the following topics:

1. **Why migration?**(“subsurface seepage of petroleum”)
2. **Primary migration**
3. **Secondary migration**
4. **Summary**

Video Lecture Review Questions:

1. True or False: the process of petroleum generation and migration is well understood, and there is much experimental evidence and direct observation to support our knowledge base in this regard.
2. Describe the chemical composition of “formation waters” in the subsurface, as related to the petroleum environment. What is the alternative term used for “formation water”? What is the relationship between depth of formation water, age, and salinity levels in the subsurface environment.
3. Describe the changes in porosity, density, formation pressure, and temperature as sediments undergo burial in a sedimentary basin over time (how do these functions relate with depth of variable, draw a generalized graphical sketch).
4. What is the general permeability of organic rich shale source rocks? (High or Low). Why does this lead to a complexity in understanding of the oil migration theory?
5. Define and describe “Primary” vs. “Secondary” oil migration.
6. List the key elements of the “Migration paradox” or the “Primary migration controversy”
7. List and briefly describe the four primary migration mechanisms that are hypothesized by petroleum geologists.
8. True or False: Primary migration typically involves oil / fluid seepage through low-permeability, organic-rich shales, while Secondary Migration involves seepage through more porous and permeable reservoir rock.
9. Draw sketches of the following migration-reservoir trapping pathways.
   1. Dipping sandstone and shale beds with stratigraphic pinchout.
   2. Anticlinal structures
   3. Reef Deposits
10. Discuss the importance of the low-permeability seal rock with respect to petroleum migration.

**Part 2. Selley Textbook Review Questions – Chapter 5: Generation and Migration of Petroleum**

Instructions: visit the ES486 class web site and download a digital MS word document version of the text review questions. Review and read the relevant textbook chapter posted on the ES486 moodle site and answer the following questions. Answers should be word-processed with MS Word using figures and pasted images from the text book or favorite internet resources. Your work should look complete and professional.

1. What are the most common types of rocks associated with economically significant, major petroleum accumulations on Earth?

2. What are the leading two types of reservoir host rocks for petroleum in North America?

3. True or False: Petroleum hydrocarbons never have been found in igneous host / reservoir rocks?

4. True or False: Hydrocarbon occurrence in the Earth Solar System is only associated with organic (life) origins.

5. List three modes of process that could result in oil accumulations in igneous rocks.

6. What is the percentage of carbon contained in calcite bearing limestones and dolomites? What is the percentage of carbon contained in organic hydrocarbons?

7. Briefly describe and write the chemical formula for plant photo synthesis.

8. List the four major groups of chemical compounds contained in organic matter:

9. What conditions are necessary to preserve organic carbon against bacterial decay in the sedimentary environment?

10. What are the two primary source of biomass production and organic carbon in the world’s oceans?

11. What latitudes are associated with the highest biomass production in modern oceans?

12. Explain how water temperature, density and stratification in the oceans sets up the framework for biomass production and organic carbon preservation.

13. List and describe the three phases of organic matter transformation during the burial and sedimentation process.

14. What carbon-based gas is derived from organic matter decay in an oxidizing environment? What carbon-based gas is derived from organic matter decay in a reducing / anoxic environment?

15. Define the term kerogen, list and describe the three basic types.

16. Describe the necessary conditions leading to the maturation of organic matter to kerogen and to petroleum.

17. What is “vitrinite reflectance” and what is it used for?

18. List the four pieces of evidence that oil and gas migrate from source rocks to reservoir.

19. Describe the difference between primary hydrocarbon migration and secondary migration.

17. Describe the source-reservoir “paradox” when it comes to hydrocarbon migration in the subsurface.

18. Examine Figure 5.23 in the textbook. Describe the relationship between sediment burial and increasing depth over time vs. porosity and geothermal temperatures. What is the temperature range that is associated with optimal oil generation window.

19. Describe the relationship between shale water content vs. depth of burial over time. Does it increase, decrease or stay the same as sediment burial progresses?

20. What is the parameter “TOC” a measure of in shale source rock?

21. List all of the necessary components of the “petroleum system”, draw a sketch.

22. Summarize the 7 important take-away messages discussed in the textbook regarding Hydrocarbon Generation and Migration.