

**EARTH SCIENCE 460 and 460L (3 credit hours)**  
**Subsurface and Petroleum Geology**  
**Lecture and Lab**  
**Spring Semester**

**Designation:** Required for Petroleum Engineering majors

**Course Description:** Principles and techniques of subsurface geology with subsurface mapping; facies and reservoir analysis; fluid-related rock properties; composition, movement and entrapment of subsurface fluids (oil, natural gas, water), and petroleum source rocks. Laboratory work emphasizes subsurface analysis of reservoirs and mapping with logs, cuttings, cross sections and subsurface maps. Applications to hydrocarbon exploration and development.

**Prerequisites:** EARTH 203 or 206 (The Earth's Crust)

**Materials:**

*Main Textbook:* Petroleum Geology, F.K. North (1985)

*Other readings:* Elements of Petroleum Geology 2<sup>nd</sup> edition, Selley (1998)  
Geology of Petroleum, 2<sup>nd</sup> edition, A.I. Levorsen (1967, reprinted 2001)  
Applied Subsurface Geological Mapping, Tearpock and Bischke (1991)  
Pore Geometry as Related to Carbonate Stratigraphic Traps, J.L. Stout (1964, AAPG Bulletin)  
Stratigraphic Traps in Sandstones – Exploration Techniques, Busch (1974, AAPG Memoir 21)  
Secondary Migration and Accumulation of Hydrocarbons, W.A. England (1994, in AAPG Memoir 60)  
Organic Geochemistry in Petroleum Exploration, C. Barker (1979, AAPG Course Note Series No. 10)

*Course notes handouts:* Porosity in carbonate rocks  
Hydrocarbon seals  
Reservoir temperatures  
Reservoir pressures  
Coalbed methane  
Shale gas

*Software:* Surfer 8 contouring package (provided in the computer lab)

**Course Objectives:**

*Lecture:*

1. Understand composition, and physical and chemical properties of oil, natural gas, and oilfield waters.
2. Understand composition and properties of sandstone, carbonate, and shale reservoirs, including capillary pressure properties.
3. Understand composition, lithologic properties, and capillary pressure properties of hydrocarbon seals.
4. Apply basic concepts of structural geology to the formation of structural traps. Analyze families of structural traps. Introduction to exploration and development concepts and predictive models.
5. Apply basic geology of fracturing to fractured hydrocarbon reservoirs.
6. Apply depositional environment of sandstone and carbonate reservoirs to reservoir geometry and orientation, rock properties, and basinal setting. Introduction to exploration and development concepts and predictive models.
7. Understand the relationships of reservoir temperatures and pressures to reservoir geology.
8. Understand how oil and natural gas are generated and what basic geologic criteria are needed to identify and assess oil and gas source rocks.
9. Apply knowledge of hydrocarbon reservoirs and seals to processes of oil and gas migration.
10. Understand the fundamentals of coalbed methane formation and occurrence.

*Lab:*

1. Map stratigraphy and structure in the subsurface using well data. Produce contour maps by hand and with the computer.
2. Interpretive contouring of subsurface data utilizing geologic knowledge.
3. Develop an understanding of core suites of borehole logs in terms of rock properties and composition and porosity and permeability.
4. Describe and analyze sandstone and carbonate reservoirs with both well cuttings and borehole logs, emphasizing the mutually supportive roles of rock description and logs.
5. Map and analyze a small oil or gas reservoir with logs, well records/results, and basic rock descriptions.

**Topics:**

*Lecture:*

1. Subsurface fluids - oil, gas, & water
2. Reservoir rocks & seals; capillary pressure properties of reservoirs & seals
3. Overview of well-site engineering and drilling operations
4. Subsurface structure & structural traps

5. Fractured reservoirs
6. Sandstone reservoirs – depositional setting, subsurface analysis, and traps
7. Carbonate reservoirs – depositional setting, subsurface analysis and traps
8. Unconformities – geometry, subsurface identification & barriers to fluid flow
9. Temperatures & pressures in the subsurface
10. Reservoir mechanics and dynamics; natural production mechanisms
11. Petroleum origin and generation; deposition of source rocks
12. Petroleum maturation
13. Identification and properties of petroleum source rocks
14. Migration from source rock to trap
15. Coalbed methane
16. Shale gas

*Lab:*

1. Structure contouring by hand
2. Structure contouring with a computer
3. Interpretive stratigraphic contouring
4. Geophysical logs – an introduction; basic geologic analysis and interpretation
5. Correlating geophysical logs
6. Analysis of a sandstone reservoir with logs and cuttings (2 week exercise)
7. Analysis of a carbonate reservoir with logs and cuttings (2 week exercise)
8. Subsurface mapping and analysis of an oil (or gas) reservoir (3 week exercise)

**Class/laboratory schedule:**

Lecture meets two times a week for 1 1/4 hour each lecture

Lab meets one time a week for 2 1/2 hours

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