Western University - Department of Earth Sciences

ES3372A: Introduction to Petroleum Systems

Fall 2017

Course Information

Lectures: Tuesday & Thursday, 8:30 – 9:20 a.m., BGS 0153

Lab: Friday, 10:30 a.m. – 1:30 p.m., BGS 0184

Pre-requisites: Earth Sciences 2260 A/B

Anti-requisite: (none)

Statement on Requisites: Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Aims of the course:

This course introduces students to the major components of ***petroleum systems*** and shows how those components interact to create petroleum ***plays*** and ***prospects***. Different plate tectonic settings provide the context for lectures describing how sedimentary basin evolution influences the physical and geochemical characteristics of source, reservoir and seal rocks. Similarly, plate tectonics determine the burial and deformational processes governing the maturation and migration of hydrocarbons and the formation of structural traps. All of these products and processes are synthesized into a coherent geological history that describes the fate of organic matter as it progresses from living ecosystems to preservation in the upper regions of the Earth's crust.

Weekly labs reinforce the lecture concepts and show how they are applied in the process of constructing a petroleum prospect map. The lab section uses a project-based learning technique, teaching a progression of analytical and critical evaluation methods including geophysical well log interpretation, petrophysical calculations, and cross-section and map construction. The labs will incorporate the use of geoSCOUT©, a standard industry software package, as well as Excel© and Surfer© to explore and describe the basic characteristics of a petroleum pool.

Transferrable professional competencies such as teamwork, communication, and project management are emphasized throughout the course. Students will be evaluated on a combination of lecture and lab material via short lab assignments, a mid-term essay, and a final exam based on lecture and lab material.

Learning Outcomes:

Upon completion of this course successful students will be able to:

- Identify and define the major components of petroleum systems.
- Illustrate and label depositional models for petroleum source rock and reservoir rock facies
- Classify and compare petroleum trap types in the context of different tectonic settings

- Interpret geophysical well log data and calculate hydrocarbon pore volume.
- Critically evaluate petroleum well data and synthesize it into a prospect map
- Speculate on the roles of plate tectonics and related basin-forming processes in the development of petroleum systems and plays.
- Develop teamwork, communication and project management skills related to petroleum prospect analysis.

Instructor Information

Instructor: Dr. Burns A. Cheadle, Associate Professor, Department of Earth Sciences

Email: bcheadle@uwo.ca **(Note: Please include 'ES 3372' in the subject line of all emails about this course)**

Office: Biological & Geological Sciences Building, Room 1078

Tel: (519) 661-2111 x89009

Office Hours: [to be determined], or by request (email bcheadle@uwo.ca)

Lecture Resources Website: https://owl.uwo.ca (log in with UWO username and password)

Note: PowerPoint presentations for each lecture will be posted no later than the evening before the lecture, and will remain on the website for the rest of the term. Note, however, that **some material in the presentations will be deliberately left out**, requiring you to fill in important terms and other information critical to the topic. You will therefore be required to come to the lectures. It follows that the PowerPoint presentations posted on OWL are not to be used as a substitute for coming to class (you have been warned). It is up to you to download the presentations when they are available and to obtain information from your classmates if you miss a class.

Course Syllabus

(Note: This is an outline of topics that will be covered, but we will adjust the emphasis on certain topics if the class has specific interests or requires more in-depth explanation. The first 18 lectures constitute the core syllabus, and one or more of lectures 19 through 23 will be offered if time permits. Consequently, lecture numbers may not necessarily correspond to a standard 50-minute lecture.)

#	Lecture (Tue/Thur 8:30 – 9:30; BGS 0153)	Lab (Fridays 10:30 – 1:30; BGS 0184)
1	Constant Craving • energy resources & society • petroleum geology as a profession • course outline & objectives	Lab 1 (Sept 8 2017) Orientation • oil and gas drilling operations • sources of petroleum geology data • installing geoSCOUT • survey systems and well identifiers
2	Get it Together • introduction to petroleum systems • components of a petroleum system	
3	Play On • uncertainty and risk • play maps and classification • prospects and plays	Lab 2 (Sept 15 2017) Querying Well Data in geoSCOUT • oil and gas well data categories • simple queries • complex queries
4	A Whole Lotta Shaking Going On • Basins and tectonic settings • Extensional Basins • Flexural Basins • Translational Basins	

#	Lecture (Tue/Thur 8:30 – 9:30; BGS 0153)	Lab (Fridays 10:30 – 1:30; BGS 0184)
5	Black Rain • production of sedimentary organic matter • preservation of organic matter • organic matter types & kerogen	Lab 3 (Sept 22 2017) Introduction to Well Logs • logging operations • routine log measurements • combining log responses
6	The Deep Dark • source rock characteristics • mudstone sedimentology • depositional settings of source rocks	
7	Cooking in the Kitchen • kerogen pyrolysis • source rock quality • primary migration	Lab 4 (Sept 29 2017) "Quicklook" Log Interpretation • lithology responses • porosity responses • fluid responses • combining log characteristics
8	Movin' On • secondary migration • carrier bed characteristics • migration efficiency	
9	Save Me • fundamental reservoir attributes • storage capacity and porosity • flow capacity and permeability	Lab 5 (Oct 6 2017) Quantitative Petrophysics* • clay volume estimation • effective porosity estimation • water saturation estimation • HCPV and net pay
10	Rolling and Tumbling • fluvial depositional systems • meandering river deposits • braided river deposits	
Thanksgiving / Fall Reading Week Oct 9-13		
11	Day at the Beach • wave-dominated shorelines • barrier island deposits	Lab 6 (Oct 20 2017) Well Log Stratigraphy • cross-section construction • stratigraphic correlation • loop-tied gridding
12	Born on the Bayou • wave-dominated estuaries • tide-dominated estuaries • deltas	
(in-class midterm examination Tuesday Oct. 24 / covers material from Lectures 1 through 9)		
13	Slippery Slope • slides and slumps • sediment gravity flows • deep marine depositional systems	Lab 7 (Oct 27 2017) Structural Mapping • data management • posting structural data • contouring structural data • isopach mapping technique
14	Born to Run • the carbonate factory • platforms and ramps • fundamental autogenic controls	
15	Living on the Edge • ramp system deposits • rimmed shelves and reefs • carbonate bank facies	Lab 8 (Nov 3 2017) Facies Mapping • log patterns for facies interpretation • facies in stratigraphic context • paleogeographic reconstruction
16	Bump and Grind • structural traps • fault-dependent closures • independent closures	
17	The Dark End of the Street • stratigraphic traps • diagenetic traps • incisions and unconformities	Lab 9 (Nov 10 2017) Prospect Mapping* • prospect map components • ordered map layers • sweet spot identification
18	Signed, Sealed, Delivered • seal properties • capillary pressure • hydrocarbon columns	

#	Lecture (Tue/Thur 8:30 – 9:30; BGS 0153)	Lab (Fridays 10:30 – 1:30; BGS 0184)
19 (optional)	Bursting Bubbles • fluid properties • hydrocarbon phase behaviour • critical ratios	Lab 10 (Nov 17 2017) Unconventional Resources • special guest lecture – details to follow
20 (optional)	Pushing and Pulling • reservoir drive mechanisms • recovery factors • enhanced recovery techniques	
21 (optional)	Money in the Bank • conventional oil case study • exploration and discovery • development and extension	Lab 11 (Nov 24 2017) Formation Pressure Test Analysis • Drill Stem Test (DST) data • AOFP Deliverability Test data
22 (optional)	Scraping the Barrel • unconventional oil plays • oil sands • oil shale	
23 (optional)	The Waters and the Wild • unconventional gas plays • shale gas • coal bed methane • methane hydrate	Lab 12 (Dec 1 2017) Production Data* • reading production plots • gas well decline analysis • mapping production data
24	Through the Looking Glass • course summary	

- indicates graded lab assignment

Course Materials

Recommended Text: Bjørlykke, K., 2015. ***Petroleum Geoscience: From Sedimentary Environments to Rock Physics, 2nd edition***. Springer. 662p. (this textbook is available through the Western Library system as a Springer e-book)

Optional Texts: James, N.P. and Dalrymple, R.W. (editors), 2010. ***Facies Models 4***. GEOtext 6, Geological Association of Canada. 586 p. *(this is the required textbook for ES 4460 A/B, and an essential reference for aspiring petroleum geologists)*

Allen, P.A. and Allen, J.R., 2013. ***Basin Analysis: Principles and Applications***. 3rd edition. Blackwell. 619 p. *(Part 4 is particularly relevant to petroleum geology)*

Required Materials: a set of coloured pencils, a straight edge / ruler, and a scientific calculator will be required for several of the labs

Methods of Evaluation

OWL quizzes (20% of total): *(short multiple-choice quiz format; one hour time limit; due Monday midnight)*
- *combination of lecture and lab material*

Graded Labs (15% of total): *(3 graded lab assignments due by the beginning of the following lab session)*
- *assignments involve application of cumulative lab learning*

Mid-Term Exam (20% of total): *(Tuesday October 24 during scheduled lecture period; 45 minutes)*
- *mixed format exam based on cumulative lecture material*

Final Exam (40% of total): *(during the scheduled exam period)*
- *mixed format exam based on cumulative lecture and lab material*

Participation (5% of total): *(to be assigned following final lecture period)*
- *participation rubric will be provided*

Due dates for assignments are firm – late submissions will not be accepted. See note (4) under "University Policies" for exceptions due to illness or special circumstances.

Use of electronic calculators is permitted during examinations, but all other electronic devices (phones, tablets, laptops) must be turned off for the duration of the examination period

---

Sessional Dates (ES 3372A specific dates in bold)

September 7	Fall/Winter Term classes begin
September 7	**ES3372A lectures begin (8:30 – 9:30 BGS 0153)**
September 8	**ES3372A labs begin (10:30 – 1:30 BGS 0184)**
September 15	Last date for late registration
October 9	Thanksgiving Holiday
October 9 - 13	**Fall Reading Week**
October 24	**Mid-term Examination**
November 12	Last day to drop a first-term half course or a first-term full course (2016-17 Fall/Winter Term) without academic penalty.
December 1	**ES4472A final lab session**
December 7	**ES4472A final lecture session (exam review)**
December 8	Fall/Winter Term classes end
December 9	Study Day
December 10-21	Mid-year examination period

The Exceptional Contributor: "The Class Was Better Because You Were Here."

As part of the learning process I expect all students to participate actively in class. Here are some guidelines to keep in mind when in class:

- You provide clear, concise, and correct explanations that help others gain a better understanding of concepts.
- You make outstanding, original, and informative comments.
- You make highly attentive and constructive comments on other people's statements.
- You ask questions that are penetrating or help clarify.
- You raise your hand strategically (understanding that there are other students in the class).
- You actively encourage others to express their ideas.
- You display body language that communicates interest in what others are saying.
- You arrive to class on time and are not absent without reason.

University Policies:

1) Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

2) Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

3) All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

4) If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Academic Counselling Unit as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Academic Counselling Unit immediately. For further information please see:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_illness.pdf
A student requiring academic accommodation due to illness should use the Student Medical Certificate when visiting an off-campus medical facility or request a Records Release Form (located in the Academic Counselling Unit) for visits to Student Health Services. The form can be found here:
https://studentservices.uwo.ca/secure/medical_document.pdf

5) Students who are in emotional/mental distress should refer to Mental Health@Western http://uwo.ca/health/mental_wellbeing/ for a complete list of options about how to obtain help.

6) For the policy on Accommodation for Students with Disabilities, refer to:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_disabilities.pdf.

7) For the policy on Accommodation for Religious Holidays, refer to:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

Accessibility Statement:

Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x.82147 for any specific question regarding an accommodation.