Western Science

Earth Sciences

Earth Sciences 4472A / 9566A (0.5 FCE)

Fall 2018

Applied Petroleum Assessment

Lectures (**beginning Tuesday September 11**)
Tuesday / Thursday, 11:30 AM – 12:30 PM
Physics & Astronomy Building, room 150

Labs (beginning Monday September 17)
Monday, 2:30 PM – 5:30 PM
Biological and Geological Sciences Building, room 0184

Dr. Burns A. Cheadle

Associate Professor, Department of Earth Sciences
Email: bcheadle@uwo.ca
Office: BGS 1078
Tel: 519-661-2111 ext.89009
Hours: Fridays, 10:30 – 11:30, or by appointment

Graduate Teaching Assistant:

(to be determined)

Prerequisites: Earth Sciences 3372A/B or special permission from the Instructor

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.

Description: This is a course that engages students to build a deeper and broader understanding of the problem of predicting where to drill successful oil and gas wells. What combination of geological, engineering, economic and social factors contributes to a successful well? How do uncertainty, risk and public perception influence the decision to proceed with a drilling and completion operation? Why is geoscience professionalism essential at all stages of the life cycle of a producing petroleum asset? These are the types of questions we will confront as we collaborate to assess the expected value of an emerging "unconventional" oil play in the Western Canadian Sedimentary Basin.

Progression: The course uses an experiential problem-based learning design, and requires a high level of engagement and participation[1] by all students. Participation in class discussion, as well as team project work, will be evaluated and will contribute to the final course grade. On a regular and rotating basis, class

[1] There are many constructive ways to participate, and we can work together to find the way that works best for each student

members will be called upon to lead the discussion to help all students critically evaluate assigned readings and other media. Two of these discussion introductions will take place as short (10 minute) oral presentations during the term, each dealing with an aspect of the Duvernay play assessment (topics to be determined in consultation with the instructor). The oral presentations will be evaluated by the instructor and student peers, using a rigorous rubric based on the AACU VALUE standard.

We will collaborate (using a Wikimedia platform) to create a document[2] that provides the general public, regulators, and industry with an unbiased, evidence-based guide to the development of the Duvernay tight oil play in west-central Alberta. We will collectively determine the document structure but notionally it could include sections such as:

- Overview of tight oil development
- Geology of the Duvernay Formation
- Resource and Recoverable Reserves estimate
- Exploration and drilling operations
- Production operations
- Health, Safety and Environment
- Socioeconomic implications

Students will form writing teams, with each individual taking leadership for contributing meaningful content to a particular section of the document. Team members will critique each others' contributions, and collaborate to ensure continuity between sections. Ultimately, grading of the report will blend a team score (for the overall quality of the report) with an individual contribution weighting factor. The individual score will be assessed through anonymous peer evaluations and individual performance reports submitted to the instructor at three dates throughout the term. Individual contributions may be verified using revision history tools. Individual contribution grades will be assigned at mid-term and final points in the course, based on a rubric of standardized expectations.

The technical contributions are necessarily a shared responsibility, and will be developed during labs using geoSCOUT (an oil and gas industry software package), as well as frequent use of Microsoft PowerPoint and Excel®, and Surfer 11©. The lab sessions will sequentially build up a foundation of basic skills that will be used to gather and analyze well log, testing and production data for the technical assessment. Much of this work will be conducted using a team approach, and the entire class will contribute to the technical project database. Other contributions to the document will benefit from our class discussions based on lectures and assigned readings. Grading for individual contributions to technical group work will include a blend of instructor, self and peer assessment. The peer and self assessment is conducted using the CATME Smarter Teamwork system, a web-based tool based on rigorous scholarly work.

A critical reflection essay, due at the conclusion of the course, will provide each student with the opportunity to describe their individual contributions, and how the course has transformed their understanding of oil and gas development.

[2] Early in the course, we can discuss the relative merits of creating a Wikipedia article as an alternative to a shared text document. The number of collaborative writing teams will be based on course enrollment.

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Learning Outcomes (in context of Western Degree Outcomes):

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

- Knowledge
  - Describe geological characteristics and operational considerations for a typical “tight oil” or “shale gas” prospect
  - Discover underlying connections by making ***play and prospect maps*** that integrate a wide range of structured and unstructured oil and gas data
  - Quantify the ***uncertainty and risk*** associated with a proposed drilling target
  - Estimate ***in-place petroleum resources and technically recoverable reserves*** for a petroleum pool
  - Estimate the economic value of the prospect in terms of risked discounted cash flow valuation.
- Literacies and Interdisciplinarity
  - Use oilfield technical language to identify, evaluate and integrate various data types
- Communication
  - Use appropriate language and reasoning to present ideas clearly to a variety of audiences
- Resilience and Life-Long Learning
  - Express how personal values and beliefs influence perception of the issues surrounding tight oil development
- Global and Community Engagement
  - Describe the interconnectedness of technical, economic, social and environmental considerations of petroleum development
- Critical Inquiry and Creative Thinking
  - Assess the reliability of different information sources based on critical evaluation of underlying assumptions, perspectives and quality of evidence
  - Adapt problem-solving strategies according to judgments about data reliability
- Professionalism and Ethical Conduct
  - Work effectively with diverse team members to contribute to a shared objective
  - Explain the ethical responsibilities of a professional geoscientist involved in petroleum development

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

Note: PowerPoint presentations will be used selectively in this course, and only when they are deemed to be useful supports for classroom discussion. Those slide decks will be posted to OWL following the relevant lecture or lab sessions, and will remain on the website for the rest of the term. In addition, lecture slides from the most recent ES 3372A (Introduction to Petroleum Systems) offering will be provided as background material.

Course Syllabus

(Note: This is a general outline of lecture/seminar and lab topics that we will discuss, but we will adjust the emphasis on certain topics depending on relevance to the term project and level of interest. For some topics, formal lectures will be replaced with a "flipped classroom" discussion of reading assignments.)

Lecture Topics

Introduction and Course Objectives
- course outline & objectives | calibrating expectations | organizational considerations

A Brief Refresher on (Unconventional) Petroleum Systems

Basin types
- tectonic settings | source and reservoir depositional settings | heat flow

Source Rock
- preservation of organic matter | transformation of kerogen | Rock-Eval pyrolysis data

Maturation and Migration
- maturity indicators | expulsion mechanics

Reservoir Characterization
- physical properties of "shale" reservoirs | quantitative petrophysical methods

Introduction to "Shale Gas" and "Tight Oil" Development

Global "Shale" Resources
- history of development | distribution of plays | business model

Drilling and Completion Operations
- horizontal wells | multistage hydraulic fracture treatment | pad development

Environmental Impacts of Shale Development
- water management | methane emissions | induced seismicity | surface disturbance

Case Study: Duvernay Shale Play

Tectonostratigraphic Setting
- Late Devonian passive margin | Woodbend reef complexes | Duvernay Shale Basins

Duvernay Stratigraphy
- Sedimentology | sequence stratigraphy | thickness and porosity

Duvernay Characterization
- Source rock parameters | geomechanical characteristics | pressure & temperature
- Petrophysical characteristics | seismic characteristics
- Production characteristics | decline behaviour | material balance

Duvernay Development
- Drilling operations | completion & stimulation operations
- Development schemes | Transportation
- Water handling | Induced seismicity | Environmental impact

Duvernay Resource Estimation
- Expected Ultimate Recovery | Regional Assessment
- Project Economics | uncertainty & risk
- Future Potential

Lab Topics

Orientation and Organization Session (Monday September 17)

- The first lab session will be used to get everybody set up with geoSCOUT software and provide a refresher[3] on the elements of the Well Ticket and how they relate to drilling, completion, testing and production operations of an oil well. This lab will not have an assignment and is intended to familiarize students with the structure of the data used for their term projects.

Duvernay Play Activity Map (Monday September 24)

- During the second lab session, we will construct a map that summarizes drilling and production activity in the Duvernay tight oil play in Alberta. This will require use of the "Search on Criteria" function in geoSCOUT as well as learning about posting different types of data on a geoSCOUT Map Window. The associated assignment will involve exporting well data and manipulating it in Excel to produce a basic statistical report of drilling and production activity. Teams will be assigned different subregions on which to report.

Source Interpretation: Quality and Generation Potential (Monday October 1)

- The third lab will involve interpretation of Rock-Eval source rock analyses for the Duvernay formation in order to construct diagnostic plots for thermal maturity and organic matter type. Data will be summarized and added to a user database that will allow the creation of source rock maps for the Duvernay interval. The maps and diagnostic plots will be submitted for grading. (note – the following Monday is the Thanksgiving holiday, followed by the Fall Reading Week. You may need to use some of this time to complete the assignment for submission on Monday October 15)

Stratigraphic Interpretation (Monday October 15)

- This lab will provide a quick review of geophysical well log responses, with a focus on the log responses associated with the Duvernay Formation and bounding formations. We will build two cross-sections through a designated project area to understand local stratigraphic variation in the thickness and "electrofacies" variation in the Duvernay Formation. These types of data will be foundational for your reserves assessment project. PDF versions of your cross-sections will be submitted for grading.

Petrophysical Interpretation: Quantitative Well Log Analysis (Monday October 22 and October 29)

- We will need two lab sessions to complete data collection and user database construction of Duvernay zonal attributes (e.g., thickness, porosity, fluid saturations, TOC). Part of the exercise will involve critically evaluating what the data will allow us to determine, and what is worth attempting to calculate and map. [graded assignment]

Integration of Fluid and Pressure Analyses (Monday November 5)

- This lab introduces techniques for gathering, quality checking, and analysis of pressure test information. Our aim is to determine the "virgin" reservoir pressure and temperature in the Duvernay Formation in our project area. We will also investigate the potential for abnormal formation pressure, which is an important consideration for well completion and productivity.

Production Data Analyses (Monday November 12)

- We will use this lab session to learn how to conduct a modified decline analysis of production data in order to estimate recoverable reserves. The method will be applied to all producing wells in the project area as part of the generally-accepted procedure for technically recoverable reserves determination. [graded assignment]

Prospect Map Construction (Monday November 19)

- The second-last lab session will bring together most of the data that we created through the term in order to create a map that can be used to identify potential prospects for future drilling (we hope!).

Basic Risked Economic Evaluation (Monday November 26)

- Our final lab focuses on creating a production forecast for the project area, and then conducting a discounted cash flow analysis to calculate the Net Present Value of our project.

[3] If necessary, the instructor will organize a Saturday intensive workshop for geoSCOUT training, to be scheduled as early in September as possible

Course Materials

The field of shale reservoir assessment is still quite new and there are few, if any, textbooks that cover the material in a way that will be helpful for this course. In lieu of a text, a list of technical papers, conference presentations and technical reports will be provided in OWL. Several of these will be required readings in advance of in-class discussions and students will be selected to lead or respond to those documents [participation and leadership will factor into course grades].

The workstations in BGS0184 will be used for the labs, and geoSCOUT and Excel are the primary software packages for project work. If required, workstations in the Petroleum Geoscience Lab (BGS 1058) may be used on a limited basis, but this is unlikely to be necessary.

Methods of Evaluation

Your assessment will be based on in-class and team participation, graded lab assignments, a term paper/presentation, and a critical reflection essay. Note: this course does not have a Final Examination.

Participation (20% of total):

- initiation and response to in-class discussions (5%, assessed by instructor based on a rubric that will be provided)
- active participation in lab sessions (5%)
- two “keynote” (discussion-opening) oral presentations (5% each)

Lab Assignments (25% of total):

- five graded lab assignments through the term

Term Paper (40% of total):

- Three Individual performance reports (due **October 4**, **November 8**, and **December 6**) (10%)
- Collaborative report (20%) [group grade multiplied by individual contribution weighting factor]
- Team oral presentation of report highlights [**December 3, 2018**] (10%)

Critical Reflection (15% of total):

- Final essay in which students reflect on how their learning experienced challenged personal opinions, beliefs and preconceived notions about oil development and the types of information sources that inform public and personal perceptions about the topic (complete instructions and a rubric will be provided); **due December 14, 2018***

** due dates for assignments are firm - 10% per day will be deducted for late assignments. See note (4) under "University Policies" for exceptions due to illness or special circumstances. The Instructor will grant accommodation, without requirement for documentation (medical or otherwise), for work 10% or less of the total course grade. Accommodations for work in excess of 10% of the total course grade, and all accommodations requiring documentation (medical or otherwise) must be referred to the student’s Academic Counselling Unit.*

Sessional Dates (ES4472 / GL9566 specific dates in bold)

September 5	Fall term classes begin
September 11	**ES4472A/GL9566A lectures begin (11:30 – 12:30 PAB150)**
September 14	Last date for late registration
September 17	**ES4472A/GL9566A labs begin (2:30 – 5:30 BGS 0184)**
October 4	**Individual Performance Report 1 / CATME input due**
October 8	Thanksgiving Holiday
October 9-12	Fall Reading Week
November 8	**Individual Performance Report 2 / CATME input due**
November 12	Last day to drop a first-term half course or a first-term full course (2018-19 Fall/Winter Term) without academic penalty.
December 3	**ES4472A/GL9566A final lab session / team presentations**
December 6	**Individual Performance Report 3 / CATME input due**
December 6	**ES4472A/GL9566A final lecture session**
December 7	Fall/Winter term classes end
December 8-9	Study Days
December 10-21	Mid-year examination period
December 14	**Critical Reflection Essay due**

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.