Western University - Department of Earth Sciences

GL9566: Applied Concepts in Petroleum Geology
Winter 2014

Course Information

***Note**: GL 9566 is co-listed with ES 4472B and shares the same lecture sessions. Evaluation criteria for GL 9566, however, differ from ES 4472B reflecting higher expectations for independent thought on the part of graduate students.*

Lectures: Wednesday 09:30 – 11:20 (BGS 1065) (*Please note that this is a two (2) hour lecture session*)

Lab: Tuesday 18:00 – 21:00 (BGS 0184)[1]

Pre-requisites: Earth Sciences 3372A[2]

Anti-requisite: Earth Sciences 4471B

Statement on Requisites: Unless you have either the requisites for this course or written special permission from your Academic Counselling Unit 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:

At the end of the course, the student should be able to create play and prospect maps that integrate ***stratigraphic***, ***petrophysical***, ***pressure***, and ***fluid*** data. The student should be able to determine the ***volume*** and ***characteristics*** of the ***mapped petroleum prospect***, and be able to estimate the ***uncertainty*** and ***risk*** associated with the prospect. Finally, the student should be able to estimate the ***economic value*** of the prospect in terms of ***risked discounted cash flow valuation***. Lectures, assigned readings from the required textbook and instructional slides will form the basis for achieving these learning objectives.

Instructor Information

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

Email: bcheadle@uwo.ca

Office: Biological & Geological Sciences Building, Room 1078

Tel: (519) 661-2111 x89009

Office Hours: by appointment

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

Note: PowerPoint presentations for each lecture will be posted the evening before the lecture (at the latest), 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

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[1] Graduate students who have not taken ES3372A, and who wish to audit the ES 4472B lab section, will be responsible for self-training on geoSCOUT software. Tutorial materials will be provided

[2] Lecture slides for ES3372A and supporting material will be made available for review purposes.

been warned), and should be considered as supplementary to the required textbook. 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 lecture and lab 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.)

Lecture Topics

Introduction and Course Objectives
- course outline & objectives | summary of petroleum systems | introduction to play and prospect assessment

Basin Analysis

Basin Analysis for Petroleum Assessment
- fundamentals of basin analysis | subsidence mechanisms

Extensional Basin Petroleum Systems
- heat flow history | rift phase systems | passive margin systems

Foreland Basin Petroleum Systems
- tectonics and stratigraphy | maturation and migration | reservoir development

Translational Basin Petroleum Systems
- transtension and transpression | source considerations | reservoir development

Burial History and Timing
- fundamentals of basin analysis | burial history plots | timing and prospectivity

Source

Source Rock Characterization
- transformation of kerogen | Rock-Eval pyrolysis data | modeling petroleum generation

Maturation and Migration
- maturity indicators | expulsion mechanics | capillarity and multiphase flow

Reservoir

Reservoir Characterization
- characterization as a discipline | scales of characterization | workflow considerations

Reservoir Architecture
- clastic architectural elements | outcrop analogs | quantitative facies modeling

Seismic Reservoir Characterization
- seismic attributes | porosity inversion | rock mechanics considerations

Petrophysical Reservoir Characterization
- quantitative petrophysical methods | scaling properties for models

Trap & Seal

Evaluation of Extensional Traps
- seismic method | fault geometries | fault seal analysis

Evaluation of Compressional Traps
- seismic imaging of thrusts | palinspastic restoration | compressional trap geometries

Evaluation of Stratigraphic Traps
- modeling unconformities | diagenetic modeling | stratigraphic vs. structural closure

Evaluation of Seal
- capillary seal | hydrocarbon column height

Engineering & Economics

Reservoir Engineering
- primary production characteristics | decline analysis | gas material balance analysis
- enhanced oil recovery | production operations

Resources and Reserves
- resources vs. reserves | reserves categories

- volumetric oil reserves calculation | volumetric gas reserves calculation

Petroleum Economics

- uncertainty and risk | time value of money | discounted cash flow analysis | economic indicators

Unconventional Resources

Oil Sands Assessment

- surface mining considerations | in-situ (thermal) recovery considerations

"Shale Gas" Assessment

- typical workflow | geomechanical considerations

Lab Topics (available to audit)

Orientation and Organization Session

- roundtable discussion of expectations
- developing a “predation image” | general assessment workflow
- geoSCOUT refresher and project set-up | creating well lists using geoSCOUT searches
- database organization in your project folder

Stratigraphic Interpretation

Correlation in geoSCOUT

- review of regional geology | criteria for picking formation tops
- avoiding the pitfall of lithostratigraphy | chronostratigraphic principles in correlation
- designing a cross-section grid | datum selection | strategies for effective correlation
- creating new user tops | quality assurance | exporting tops

Quantitative Well Log Analysis

Basic Well Log Analysis

- "quick look" techniques | lithology prediction | porosity and saturation calculation
- fundamentals of carbonate well log analysis

Shaly Sand Log Analysis

- clay volume estimation | effective porosity calculation | bound water volume
- hydrocarbon pore volume determination

Integration of Fluid and Pressure Analyses

Working with Water Analysis Data

- reading a water analysis report | quality control of water analyses
- formation water resistivity (Rw)

Working with Pressure Data

- reading a DST report | reading a flow and buildup test report | spotting problem tests
- hydrostatic and hydrodynamic analysis of test data | prediction of fluid contacts | prediction of hydrocarbon column height
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Map Construction and Interpretation

Mapping in geoSCOUT

- posting user tops | quality assurance | contouring map data

Working With Reserves and Production Data

- production performance indicators | mapping production data
- volumetric reserves calculation | decline analysis | gas material balance | reserves reconciliation

Play and Prospect Risking

- calculating chance of success | COGEH classification

Course Materials

Required Text: Bjørlykke, K., 2010. ***Petroleum Geoscience: From Sedimentary Environments***

to Rock Physics. Springer. 508p. (note that this textbook is available through the Western Library system as a Springer e-book)

Optional Text: Allen, P.A. and Allen, J.R., 2005. ***Basin Analysis: Principles and Applications***. 2nd edition. Blackwell. 549 p. *(Chapters 8, 9, and 10 are particularly relevant to petroleum geology)*

(Citations for required readings and reference materials will be made available by the instructor throughout the course via OWL)

Methods of Evaluation

Assignments 1 and 2 will require submitting a written report in the form of a technical critique of a journal article (or series of related articles) to be selected in consultation with the instructor. Similarly, the Petroleum System report topic will be chosen in consultation with the instructor. Selections of these topics should take place prior to the third week of the course, so it is strongly recommended that the student make an appointment with the instructor at his or her earliest convenience. Written guidelines for report format and content expectations will be made available during that appointment.

- Assignment 1 (20%)..... *due** February 12, 2014*
- Assignment 2 (20%)..... *due** March 5, 2014*
- Petroleum System Report (40%) ..... *due** April 5, 2013*
- Petroleum System Oral Presentation (20%)..... *presentations on April 1, 2014 (during ES 4472B evening lab session)*

*** 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 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/handbook/appeals/scholoff.pdf

2) Unless you have either the requisites for this course or written special permission from your Academic Counselling Unit 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/handbook/appeals/medical.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

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.