



UNIVERSITY OF CALGARY  
FACULTY OF SCIENCE  
DEPARTMENT OF GEOSCIENCE  
COURSE OUTLINE  
WINTER 2016

1. **Course:** Geology 655, Unconventional Gas Reservoir Characterization and Evaluation

Lecture Sections:

L01: January 19, 2016, 08:00-16:00, ES 136  
January 21, 2016, 08:00-16:00, ES 136  
February 9, 2016, 08:00-16:00, ES 136  
February 11, 2016, 08:00-16:00, ES 136  
April 5, 2016, 08:00-16:00, ES 136  
April 7, 2016, 08:00-16:00, ES 136

Instructor, Dr. C. Clarkson, Office ES 254A, Tel. No. 403-220-6445, e-mail address, [clarksoc@ucalgary.ca](mailto:clarksoc@ucalgary.ca),  
Office Hours: WedFri 9:00-10:00

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2. **Prerequisites:** Petroleum Engineering 523 or consent of the instructor. See section 3.5.C in the Faculty of Science section of the online Calendar ([www.ucalgary.ca/pubs/calendar/current/sc-3-5.html](http://www.ucalgary.ca/pubs/calendar/current/sc-3-5.html))

**Antirequisite:** Credit for both Geology 655 and 699.37 will not be allowed.

3. **Grading:** The University policy on grading and related matters is described sections F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Quizzes	40% (1 in lecture block 2, 1 in lecture block 3)
Term paper + presentation	60% (lecture block 3)
	➤ Evenly weighted between paper and presentation

Each piece of work (quiz and term paper) submitted by the student will be assigned a percentage score. The student's average percentage score for the various components listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade. The conversion between course percentage and letter grade is given below.

Letter Grade	Percent	Letter Grade	Percent
A+	95-100	C+	64-67
A	89-94	C	60-63
A-	84-88	C-	56-59
B+	78-83	D+	53-55
B	73-77	D	50-52
B-	68-72	F	0-49

4. **Missed Components of Term Work:** The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in [Section 3.6](#). It is the student's responsibility to familiarize himself/herself with these regulations. See also [Section E.6](#) of the University Calendar

5. **Course Materials:** Students will be provided reading materials before each lecture block.

6. **Examination Policy:** Quizzes are closed book. Calculators will be allowed. Students should also read the Calendar, [Section G](#), on Examinations.

7. **OTHER IMPORTANT INFORMATION FOR STUDENTS:**

(a) **Academic Misconduct:** (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The

Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under [Section K](#). Student Misconduct to inform yourself of definitions, processes and penalties

- (b) **Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on [assembly points](#).
- (c) **Student Accommodations:** Students needing an Accommodation because of a Disability or medical condition should contact Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities available at [http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities\\_0.pdf](http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities_0.pdf). Students needing an Accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to the Associate Head of Geoscience, Dr. E.S. Krebs by email [krebs@ucalgary.ca](mailto:krebs@ucalgary.ca) or phone 403-220-5850.
- (d) **Safewalk:** Campus Security will escort individuals day or night (<http://www.ucalgary.ca/security/safewalk/>). Call 220-5333 for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.
- (e) **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). As one consequence, students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information see also <http://www.ucalgary.ca/secretariat/privacy>.
- (f) **Student Union Information:** VP Academic Phone: 403 220-3911 Email: [suvpaca@ucalgary.ca](mailto:suvpaca@ucalgary.ca)  
SU Faculty Rep. Phone: 403 220-3913 Email: [science1@su.ucalgary.ca](mailto:science1@su.ucalgary.ca), [science2@su.ucalgary.ca](mailto:science2@su.ucalgary.ca) and [science3@su.ucalgary.ca](mailto:science3@su.ucalgary.ca);  
Student Ombuds Office: 403-220-6420 Email: [ombuds@ucalgary.ca](mailto:ombuds@ucalgary.ca); <http://ucalgary.ca/provost/students/ombuds>
- (g) **Internet and Electronic Device Information:** You can assume that in all classes that you attend, your cell phone should be turned off unless instructed otherwise. Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.
- (h) **U.S.R.I.:** At the University of Calgary, feedback provided by students through the Universal Student Ratings of Instruction (USRI) survey provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses ([www.ucalgary.ca/usri](http://www.ucalgary.ca/usri)). Your responses make a difference – please participate in USRI Surveys.

Department Approval: ORIGINAL SIGNED

Date: December 16, 2015

Associate Dean's Approval for

Alternate final examination arrangements: ORIGINAL SIGNED

Date: December 22, 2015

## **COURSE CONTENT, OBJECTIVES AND ORGANIZATION:**

The aim of this course is to provide a review of unconventional gas and light oil reservoir characteristics and an overview of methods used to characterize and evaluate them. The first part of the course will focus on fundamentals of unconventional gas reservoirs including gas storage and transport mechanisms, volumetric and material balance reserve estimation and completion and stimulation methods. The second part of the course will focus on reservoir characterization techniques including core analysis, and pressure- and rate-transient (production data) analysis. Lastly, exploration and development concepts will be introduced. Real-world examples will be used wherever possible to demonstrate concepts and workflows.

The objectives of the course are to provide a working knowledge of advanced techniques for the evaluation of unconventional reservoirs. A detailed outline of the course is provided below (**\*timing is approximate**):

### **1. Introduction (Day 1)\***

- a. Unconventional Gas (UG) and Unconventional Light Oil (ULO) Reservoirs
- b. UG and ULO Definitions
- c. Featured Plays

### **2. Introduction to Tight Gas Case Study (Day 1)\***

### **3. Fundamentals (Day 1)\***

#### **Unconventional Reservoir Fundamentals**

- a. Pore Structure and Gas Storage Mechanisms
- b. Hydrocarbons-in-Place
- c. Material Balance
- d. Gas and Water Transport Mechanisms
- e. Completions and Microseismic

#### **Field Development Workflow**

### **4. Reservoir Sample Analysis (Day 2)\***

#### **Routine Measurements**

- a. Core Preparation
- b. Porosity
- c. Pore Size Distribution
- d. Permeability
- e. Stress-Dependence of Porosity and Permeability
- f. Mercury Intrusion: Capillary Pressure

#### **Special Core Analysis**

- a. Wettability
- b. Relative Permeability
- c. Rock Mechanical Properties

#### **Organic Matter Characterization (CBM and Shale)**

#### **Gas Content and Adsorption Isotherm Determination (CBM and Shale)**

#### **Inorganic Matter Characterization**

#### **Selected Case Studies**

## 5. Rate-Transient (Production Data) Analysis (Day 3/4)\*

### Field Development Workflow Introduction to RTA Concept

#### Example Flow Regime and Rate-Transient Signatures

- a. Vertical Wells
- b. Horizontal Wells (non-stimulated)
- c. Multi-fractured Horizontal Wells

#### Analytical Methods for RTA

- a. Overview of RTA Methods
- b. Type-Curve Methods
- c. Straight-Line Methods

#### Forecasting Methods

- a. Overview of Forecasting Methods
- b. Analytical Methods
- c. Hybrid Methods
- d. Empirical Methods
- e. Semi-Analytical Method

#### RTA Workflow

#### RTA Workflow Examples

- a. Shale Gas
- b. Shale Gas (Enhanced Fracture Region)
- c. Tight Oil
- d. Liquid-Rich Shale

#### Additional RTA Examples (TGS, Complex Reservoir Properties)

#### Flowback Analysis

## 6. Pressure-Transient (Welltest) Analysis (Day 4/5)\*

### Field Development Workflow

#### Conventional PTA Concepts: Buildup Tests

#### Methods for Tight Formations/Shale

- a. Issues with Testing Tight Formations/Shale
- b. Example Use of Post-Frac BU for Tight Formations/Shale
- c. Alternative Methods for Testing Tight Formations/Shale

#### Diagnostic Fracture Injection Tests

- a. DFIT Concept and Theory
- b. Before-Closure Analysis (BCA) Methods
- c. After-Closure Analysis (ACA) Methods
- d. Application of Barree "Holistic" Fracture Diagnostic Approach
- e. Application of Pressure Transient Analysis Approach
- f. Detecting Fracture Complexity using DFITs
- g. Simulating DFITs for Understanding

## **7. Exploration and Development (Day 5/6)\***

### **Exploration Concepts**

- a. Subsurface Considerations
- b. Unconventional Exploration Concepts
- c. Applicability of Conventional Play/Prospect Analysis
- d. Monte Carlo Simulation
- e. New Unconventional Prospect Analysis Techniques

### **Selected Development Case Studies**