

ERTH 3405 – Geophysical Methods

Geophysics, in part, is the measurement of contrasts in the physical properties of materials beneath the surface of the Earth and the attempt to deduce the nature and distribution of the materials responsible for these observations. These contrasts in physical properties then permit the explorationist to map in detail bedrock topography that is present at depths. These techniques can result in extracting the form and distribution of alluvial sand and gravel deposits or to trace a buried river channel, to find the buried stone walls of an ancient city, or define guidelines for groundwater use based on the results of geophysical surveys, etc.

The goal of this class is to equip the student with the tools to explore Earth's subsurface. When subsurface information is needed, and is difficult to obtain directly from observation, we acquire physical measurements on the surface and use various techniques to deduce the subsurface geology. The tools discussed in this course are applicable to the collection of data in the field, or to the interpretation of data collected and applied to numerous important targets: identifying sources for much-needed resources, protecting water supplies, providing safe building sites, locating areas for safe disposal of certain wastes, or simply furthering our understanding of the Earth.

Due to the increasing interest in the shallow subsurface, we focus on methods and approaches that are appropriate for the shallow target. Seismic methods are discussed first, i.e. refraction and reflection seismology, followed by electrical resistivity methods as they are often used in conjunction with seismic work for investigations at shallow depths. Finally, we will touch on gravity and magnetic surveying techniques. The main objective is to cover the fundamental principles of common methods of exploration geophysics, and applying these ideas to practical examples.

Prerequisites: ERTH 2105.

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Office hours: Wednesday 10:00 - 12:00 pm, or by appointment

Teaching Assistants:

TBD

Office hours: TBD

TBD

Office Hours: TBD

Course Text

Introduction to Applied Geophysics – Exploring the shallow subsurface
H. Robert Burger, Anne F. Sheehan and Craig H. Jones, 1992
Books available at the bookstore and the library.

Course Topics:

- Introduction to geophysics: definitions and scope, use of physical measurements in determining the subsurface properties of the Earth.
- Seismic surveying: stress and strain, seismic waves, reflection and refraction of seismic waves, critical refraction, rays and waves. Seismic refraction surveying: seismic sources and detectors, geometry of refracted ray paths for horizontal, dipping and undulating layers, data interpretation.
- Electrical surveying: Resistivity of rocks, electrode arrays and current flow in the ground, resistivity sounding and profiling
- Gravity surveying: basic theory, instrumentation, and anomaly interpretation.
- Magnetic surveying: basic theory, rock magnetism, Earth's magnetic field, instrumentation, anomaly interpretation.

Learning Objectives

- Explain applications and limitations of different geophysical surveying methods
- Analyze and interpret geophysical data using computer-based methods
- Perform seismic surveying, analyze and model the observations
- Explain, analyze and interpret electrical and magnetic surveying data
- Apply, interpret and model the gravitational data for near surface surveying

Grading Scheme:

Laboratory attendance and assignments	30%
Exam 1 (Oct. 10?)	30%
Exam 2	40%

The laboratory assignments will be a combination of theoretical practice problems, more practical applications solved on the computer and some field exercises. They should be completed within the scheduled laboratory time, but if extra time is needed then they will be due by the start of the following lab period. I encourage you to discuss the problems with your classmates, but it is absolutely imperative that any work you submit is your own. This means you must very clearly attribute any quotations or copied figures (citing name + year + publication of any sources). You should always mention any classmates with whom you have collaborated (a brief marginal note will suffice), and it is not EVER permitted to copy another student's work. If you are found to be in violation of this policy, there are very serious consequences. The instructor *is required* to report all incidents (or suspected incidents) of plagiarism to the Dean.

Exam 1 will be an in-class exam and will consist of long answer questions. Exam 2 will be in the formally scheduled exam time and will also be long answer.

For all labs and exams *always* show your full working for mathematical problems. As well as making it much easier to judge where/if you made any errors, I will not award full marks if the logic and work-flow of the answer is not clear. Make sure to properly highlight your final answer to each problem. Answers should be mathematically *correct*, i.e. if you write an "equals sign", both things on either side of it must be equal. This sounds totally obvious, but it is often not done, leading to avoidable errors and marks deducted. **Get in the practice of being meticulous with your mathematics!**

COURSE REQUIREMENTS:

- Attendance at laboratories is mandatory. It is required that you email your TA to advise of absences due to illness or emergencies in order not to lose attendance points.
- The lab component of the course must be passed in order to pass the course. You must pass the lab component of the course in order to write the final exam. The final exam must be passed in order to pass the course.
- Labs must be handed in on time. Late labs will be accepted in the instance of illness, with medical note, or in the instance of emergencies, by consultation with your TA.
- It is the student's responsibility to come to classes and labs prepared.
- Regularly log onto the CU Learn course website to check for announcements, course information, laboratory assignments and lecture material.
- Lab exercises will be posted on CU Learn. Print them off and bring to the lab period.

Tentative Schedule (note: it is subject to change):

Week	Class Date	Topic	Lab
1	Sept. 5	Seismic exploration: Fundamental Considerations I	NO lab
2	Sept. 12	Seismic exploration: Fundamental Considerations II	Introductory lab
3	Sept. 19	Seismic refraction I	Lab 1 – seismics
4	Sept. 26	Seismic refraction II	Lab 2 – refraction
5	Oct. 3	Seismic refraction/reflection	Lab 3 – refraction
6	Oct. 10	MIDTERM	Review
7	Oct. 17	Seismic reflection	Lab 4 – refraction/reflection
8	Oct. 24	FALL BREAK	
9	Oct. 31	Seismic reflection	Lab 5 – reflection
10	Nov. 7	Electrical resistivity	Lab 6 – reflection
11	Nov. 14	Electrical resistivity	Lab 7 – resistivity
12	Nov. 21	Electrical resistivity / gravity	Lab 8 – resistivity
13	Nov. 28	Gravity	Lab 9 – resistivity
14	Dec. 5	Review	NO lab

ACADEMIC INTEGRITY

It is your responsibility to review Carleton's policy on Academic Integrity - Section 14 of the Calendar.

<http://calendar.carleton.ca/undergrad/regulations/academicregulationsoftheuniversity/acadregsuniv14/>

Plagiarism

The instructor is required to report all incidents (or suspected incidents) of plagiarism to the Dean. **All work handed in must be your own.** Plagiarism and cheating are viewed as being particularly serious and the sanctions imposed are accordingly severe. Students are expected to familiarize themselves with and follow the Carleton University Student Academic Integrity Policy. The Policy is strictly enforced and is binding on all students. Plagiarism and cheating – presenting another’s ideas, arguments, words or images as your own, using unauthorized material, misrepresentation, fabricating or misrepresenting research data, unauthorized co-operation or collaboration or completing work for another student – weaken the quality of the graduate degree. Academic dishonesty in any form will not be tolerated. Students who infringe the Policy may be subject to one of several penalties including: expulsion; suspension from all studies at Carleton; suspension from full-time studies; a refusal of permission to continue or to register in a specific degree program; academic probation; or a grade of Failure in the course.

REQUESTS FOR ACADEMIC ACCOMMODATION

Please review the Carleton’s Student Guide to Academic Accommodations at

<http://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf>, and the websites therein.

For Students with Disabilities:

“The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your ***Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation.*** After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (www.carleton.ca/pmc) for the deadline to request accommodations for the formally-scheduled exam . “

For Religious Observance:

1. *As soon as you receive your course syllabus*, identify any potential conflicts between your religious obligations and course requirements. **2.** Make a formal written request to your instructor indicating the nature of the religious obligation and suggest possible alternative dates and/or means of satisfying the academic requirements. *NOTE: Such request should be made during the first two weeks of the term*, or as soon as possible after a need for accommodation is known to exist, but in no case later than the second last week of classes for that term. For detailed information on Religious Obligations please visit our website at: carleton.ca/equity/accommodation/academic.

For Pregnancy:

A. For final exams. Identify and discuss your needs for final examinations with your professors. When an agreement is reached fill out and submit the online **Pregnancy Accommodation Final**

Exam Request Form at: carleton.ca/equity/accommodation. Equity Services will forward the request to Exam Services to coordinate the accommodation. **B.** For in-class accommodations **ONLY**. If you anticipate you will only require in-class accommodations, discuss them directly with your course instructor. This request should be made in the first two weeks of the academic term. For detailed information on pregnancy and parental leave policies please visit the website at: carleton.ca/equity/accommodation/academic/