JGA305: Environmental and Archaeological Geophysics

Department of Earth Sciences and Department of Anthropology
University of Toronto, Fall 2016

Information

Meetings: Mondays, 5-8 pm
Classroom: ES1067
Instructor: Charly Bank, <charly.bank@utoronto.ca>, (416) 978-4381
office hour: Tuesday 3:30-4:30 and by appointment
Teaching Assistant: Erica Veglio <erica.veglio@mail.utoronto.ca>
Textbook: UBC-GIF and UC Berkeley online material listed below

About this course

Calendar description: *Application of near-surface geophysical methods to investigate environmental and archaeological sites; in particular magnetometry, resistivity, ground-probing radar, and seismic surveys. Course will cover background on the various methods, and allow students to run field surveys and present on case studies.*

Both science and archaeology students are welcome to enroll in this course; I will allow some choice in assignments to allow each group to excel. In addition, I encourage students from different backgrounds to work together and help one another master the new concepts. ESS450 Geophysical Field Techniques offered in late summer at Deep River, Ontario, makes an ideal companion to this course as it allows for more involved fieldwork.

This course covers a range of geophysical methods. The title reflects my current work in near-surface geophysics, and the fact that you will get an opportunity to work with some of our field equipment hands-on. However, geophysical methods are used in a much broader range of applications, inluding for mineral exploration, and at scales ranging from small over regional to planetary. The assignments will allow for some flexibility in selecting applications that interest you the most. We will not shy away from theory (physics), simple calculations, and computer modeling, yet the focus will be on discussing key ideas, and investigate successes as well as pitfalls of each method (failures typically do not make it into the literature).

Course objectives

By the end of this course, students will be able to:
1. discuss basic theory behind different geophysical methods,
2. explain geophysical equipment commonly used in field studies,
3. appraise the usefulness of a certain method for a given question,
4. read critically scientific papers and reports,
5. relate near-surface geophysics to other disciplines,
6. produce meaningful graphs and clear paragraphs to organize data and thoughts,
7. communicate their ideas and work as a member of a team.

Assessment

2 x 15% tests will consist of short answers, diagrams, and one long answer; each will last 60 minutes.

2 x 5% brief documentations of surveys you did on campus. You will need to sign up for the surveys. The documentations will be due at the end of the survey.

6 x 10% assignments: each week you will be required to complete an assignment. Typically you will be asked to model some data or calculate a response, explain a given dataset, and summarize a paper.

Tentative schedule and topics

date	topic
12 Sep	introduction, key concepts of potential field methods
19 Sep	gravity
26 Sep	magnetics
03 Oct	resistivity
10 Oct	*Thanksgiving, no class*
17 Oct	**term test 1**
24 Oct	key concepts of wave methods
31 Oct	ground-penetrating radar
07 Nov	*Fall Break, no class*
14 Nov	seismic refraction and surface waves
21 Nov	seismic reflection, electro-magnetic surveys
28 Nov	**term test 2**
05 Dec	linear inversion

Online resources

In lieu of reading a textbook I want you to use these websites for learning. Be proactive because I will not point you to specific webpages each class.

- UBC Geophysical Inversion Facility:
  Geophysics for Practicing Geoscientists is an excellent and interactive overview of key methods, and Inversion for Applied Geophysics includes introductions to potential field methods (DC resistivity, magnetic surveys, and gravity surveys)
- The Berkeley Course in Applied Geophysics is an online textbook.

SIGkit = Students Investigating Geophysics toolkit

This is a brand-new set of teaching tools my colleague Sarah Kruse (University of South Florida), myself, and several of our students from both universities have been developing this summer. It is built using the MATLAB programming language, yet the goal is that it will run independently. As I write this the toolkit is still being developed, and I do not expect that it will be ready to run independently of MATLAB when the course starts. I suggest students buy a license for CAD 15 at http://sites.utoronto.ca/ic/software/detail/matlabStudent.html to be able to run the modeling and

visualisation software we are creating. You are among the first to experience the toolkit and we welcome feedback and suggestions.

Notes

textbooks: If you would like to learn more about a specific method, especially if you are intrigued and and want more details (I can really only highlight key points in class) I suggest you get hold of a textbook. I have used the following books for my own learning:

- Milsom and Eriksen: *Field Geophysics* (4th ed.,Wiley, 2011) a short reference which provides brief but informative chapters on the various methods.
- Mussett and Khan: *Looking into the Earth* (Cambridge, 2000) is written with novice learners in mind.
- Everett: *Near-Surface Applied Geophysics* (Cambridge, 2013) is a recent textbook.
- Burger/Sheehan/Jones: *Introduction to Applied Geophysics* (Norton, 2006) is a solid introduction to geophysical surveys.
- Reynolds: *An introduction to applied and environmental geophysics* (Wiley, 2011) is a good read.
- Sharma: *Environmental and Engineering Geophysics* (Cambridge, 1997) is suitable as a more in-depth reading, and includes a chapter on inversion.
- Telford: *Applied geophysics* (Cambridge, 1990) is the classic reference but quite advanced.
- Conyers: *Ground-penetrating radar for archaeology* (AltaMira Press, 2004), and
- Aspinall/Gaffney/Schmidt: *Magnetometry for archaeologists* (AltaMira Press, 2009) are more descriptive texts and focus on the two methods most commonly used to assess archaeological sites.

journals UofT libraries subscribe to several geophysics journals, including the following in which you will find interesting articles, including case studies:

- Journal of environmental and engineering geophysics
- Archaeological prospection
- Geophysics

electronic devices (e.g., laptops, tablets, cellphones): Studies have shown that not the student doing non-course related activities on devices during class time, but fellow students in the vicinity are being distracted from engaging with the class material. I urge you to be considerate of your peers, and use devices for course-related activities only.

communication: The course website maintains a discussion board, plus information. Please mark emails clearly with "JGA305" in the subject line, I will try to answer within one working day. My office is room 2107, feel free to drop by with questions and/or concerns.

missed tests, late hand-ins: Please see the departmental website for our policy CHECK and talk to me if you know in advance that you cannot make a deadline, or if caused by reasons out of your control let me know as soon as possible afterwards. Note that you have 1 week after a missed test to petition.

accommodations: Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or Accessibility Services. If you feel stressed, or need to talk about non-course-related issues, check in with your college registrar and approach CAPS.

grades: For meaning of grades see the Grading Regulations section in the Calendar.

academic integrity: We encourage students to work and study together, but any work you submit as term work or produce during tests must be yours and yours alone. Please read the Note on Academic Offences CHECK on our department website.

time of day: this is a late and long meeting time, which overlaps with a typical dinner time. I have no problems with you bringing a snack; please avoid anything that smells too delicious. I will not lecture for 3 hours straight, but will sprinkle lecture segments with hands-on activities, paper exercises, discussions, and a break.