Introduction to Geophysics

Geow-B402-V2

Instructor Info

- R. Drews; R. Schlegel
- Office Hrs: on demand.
- GUZ 3M07
- Website
- reinhard.drews@uni-tuebingen.de

Course Info

- Prereq: None
- Tues & Thurs
- 08:00-10.00
- Online

Field Exercises

- In sub-groups of 6
- Three field exercises done in groups over two weekends.
- Outside.

Add. Instructors

- Prof. P. Dietrich
- Office Hrs: On demand
- UFZ, Leipzig
- P. Seibel
- -

Overview

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This course provides a broad overview in applied geophysics with a focus on the most common sub-surface imaging techniques: gravimetry, magnetics, geoelectrics, electromagnetic induction, ground-penetrating radar and seismics. We will discuss applications in industry as well as for general scientific questions in the geo- and environmental sciences.

Lecture Format

The lecture is accompanied with three mandatory, hands-on field exercises that will be conducted in small groups. The field measurements are done on two weekends and will be concluded with a report. Participation is a requirement for the exam. The lecture format contains lectures on Tuesdays and Thursdays in 3M07, homework in form of exercises, and in some cases flipped classroom format.

Learning Goals

You should get a broad overview for a number of geophysical methods imaging the sub-surface. You should understand the underlying physical principles, which will enable you to go deeper into specific methods that you may encounter later on. Most importantly you should learn to think straightforwardly, to ask the right questions, and to apply quantitative mathematical methods in problem solving.

Homework exercises

The homework in form of exercises and problem sets are an important part of the Geophysics lecture. They will treat some aspects of the lecture in more detail, but also cover new ground. We expect that you work on the exercises at home and we will discuss solutions together in class. We will not control whether you do the exercises or not, however, we highly recommend that you do and we will ask similar questions in the exam.

Field exercises

We will conduct field exercises for magnetics, geoelectrics and seismics. This is your maybe once-in-a-lifetime chance to work with professional geophysical equipment. The practical part of the exercises takes about 3-5 hours per method, and it is possible to do all of it in two days. Exercises are mandatory and absence is only permissible with a substantiated excuse approved by the instructor before the exercise takes place. The exercise will then need to be repeated another day. Don't miss the submission deadline of July 4th at 23:59. If you fail the report, you will have a chance to revise it.

Exercises	Location	Time Frame
Weekend 1 (incl. Friday afternoon)	Lauswiesen	07-09.06 2024
Weekend 2 (incl. Friday afternoon)	Lauswiesen	14-16.06 2024

Course organisation

Sign-up is required both on ALMA and ILIAS. All communication will be handled via Ilias, including video ressources, sign up for field exercises and a forum for questions pertaining to the exercises sheets. The course is open to a maximum amount of 70 students, preference is given to those for which this course is mandatory.

FAQs

Is this course hard?

Not sure. Rumor has it that the workload is comparatively high. All of you took quite difficult math classes and we will use these, e.g., including differentiation, integration, some linear algebra (e.g. vector fields). We will also brush on computational techniques. Exam relevant content will stick to a BSc level, but hopefully you will also be prepared for higher MSc courses.

How to pass the exam?

Maybe don't google every question during the term. Other than that may the force be with you.

Why do I have to suffer through this?

Even if you don't like geophysics you will learn a mathematical & quantitative approach that people find useful later on. Because we know you don't trust us we made this course mandatory.

Can I call myself a geophysicist after this course ?

This might be a stretch, but on the other hand this is not a protected term. Go for it! (Advises you career-coach).

Material

Books in English

- Ikelle: Introduction to Earth Sciences: A Physics Approach , available online through UB (https://doi.org/10.1142/11631).
- Hinze et al., Gravity and Magnetics - Principles, Practices, and Applications, available online through UB
- Florsch & Muhlach: *"Everyday Applied Geophysics 1/2"*, (Elsevier).
- Telford: *"Applied Geophysics"*, ca. 750p.
- Sharma: *"Environmental and Engineering Geophysics"*, ca. 470 p. (Cambridge University Press)
- Griffiths, King: *"Applied Geophysics for Geologists & Engineers"*, ca. 220 p. (Pergamon Press)
- Lowrie: *"Fundamentals of Geophysics"*, ca. 340 p. (Cambridge University Press)

Books in German

- Bender: *"Angewandte Geowissenschaften Bd.II: Methoden der Angewandten Geophysik und mathematische Verfahren in d. Geowissenschaften"*, ca. 750p.
- Militzer, Weber: *"Angewandte Geophysik"*, 3 Bände.
- Clauser: *"Einführung in die Geophysik: Globale physikalische Felder und Prozesse in der Erde"*, ca. 420p.
- Clauser: *"Grundlagen der angewandten Geophysik - Seismik, Gravimetrie: Globale physikalische Felder und Prozesse in der Erde"*, ca. 370p.
- Knödel, Krummel, Lange: *"Geophysik. Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) - Handbuch zur Erkundung des Untergrundes von Deponien und Altlasten"*, Band 3.

Some books are available as online resource at UT. Review journal articles will be provided on Ilias.

Expectations for the exam

The written exam will contain a number of basic questions probing your knowledge of the specific topics covered in class. You can answer those typically in a few sentences. There will also be longer questions which resemble those of the weekly exercises. If you visited the lectures and did the exercises (plus some repetition prior to the exam) this should be enough to make it. For better grades you will need to answer some questions where knowledge needs to be transferred to a problem set that we did not cover in class. Unsurprisingly, the best exam preparation is usually to solve the exercise sheets independently, and to actively participate in the lecture & report writing. Our goal is that the large majority of you passes the exam.

Grading Scheme

20%	Grade of field report.
80%	Written exam at the end of the term.

The report is graded and passing is pre-requiste for the exam. If your grade of the exam is better than the one from the report, *only* the exam will count. Grades will follow the standard scale, scaling is at my discretion.

Class Schedule

Part 1: Seismics & Seismology

Ressources: Clauser (2018) Chapter 2; Telford, Chapter 4

Lecture 1	16.04 (Schlegel)	• Introduction lecture format & scope of applied geophysics • Introduction wave-based methods (GPR, Seismics)
Lecture 2	18.04 (Schlegel, flipped)	• Wave equation and wave types (body (p,s) & surface) • Rays, refraction & reflections (fermat & huygens & snell's law)
Lecture 3	23.04 (Drews)	• Principal of seismic data aquis. & interpret of shot gathers • Horizontal one layer case (refraction)
Lecture 4	25.04 (Drews)	• Multiple and dipped layers (refraction) • Application examples
Lecture 5	30.04 (Drews)	• Reflection seismics principles • Velocity analysis
Lecture 6	02.05 (Drews)	• Imaging & migration • Application examples
Lecture 7	07.05 (Drews)	• Seismology & Earthquake location • Fault plane solutions & Application examples