# Global Geophysics

*Investigating the planet beneath our feet*

UG Code: GEOL0012

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# Course Aims and Goals

Global Geophysics covers topics ranging from the study of the surface directly beneath our feet all the way to the deep interior of the Earth. The aim of the course is to introduce you to the concepts, methods and results of solid Earth geophysics. We will achieve this through the understanding of the fundamental physics, which describes the behavior of nature, and the tools we use to investigate some fascinating planetary processes. This course will examine not only the theory and application of geophysical methods, but also give you an understanding of their limitations and review the contributions they have made to our knowledge of the surface and interior of the Earth.

# Assessment and Feedback

**Assessment of module** (more details on Moodle)**:**

- One 2hr 30min examination paper (70% of the final marks)
- Four course assignments (10%)
- Two MatLab practicals (10%)
- End-of-module test based on coursework and past papers (10%)

**Feedback** (more details on Moodle)**:**

Written Feedback

Your coursework will be returned to you one week after you hand it in, with a letter grade, and will usually also contain written comments. You are encouraged to discuss any questions you may have answered incorrectly with the demonstrator during the problem/practical classes.

Verbal Feedback

If you have questions about the module in general, or about work that you have submitted, you are encouraged to ask either the demonstrator at the problem/practical class or the Module Organiser (Prof. Lidunka Vočadlo) for help.

# Course Outline

| Week | Topic | Practical |
|---|---|---|
| 1 | Plate Tectonics and Euler Poles | CW1: Euler Poles |
| 2 | Gravity | CW2: Gravity |
| 3 | Elasticity and Equations of State | CW3: Elasticity and EoS |
| 4 | Seismic Waves | CW4: Seismic Waves |
| 5 | Earthquakes | MatLab revision |
| 6 | Thermodynamics | MatLab Practical 1 |
| 7 | The Deep Earth – Bring Laptops | MatLab Practical 2 |
| 8 | Heat | Test Revision |
| 9 | Magnetism and the Core | Test Revision |
| **10** | **Moodle Test – Bring Laptops** | **N/A** |

For more details of the course please refer to the GEOL0012 Module on Moodle:
http://www.moodle.ucl.ac.uk/

# Course Contents

## Topics Include:

### Lecture 1: Plate Tectonics and Euler Poles

Plate tectonics
Euler poles
Absolute plate motion
Geometry of spreading centres

### Lecture 2: Gravity

Gravitational relations and the geoid
Gravitational anomalies and corrections
Isostacy
Moment of Inertia

### Lecture 3: Elasticity and Equations of State

Elasticity:
*Stress, strain and elastic moduli*
*Poisson's ratio*
*Adams-Williamson equation*

Equations of state:
*Simple equations of state*
*Murnaghan Integrated Linear Equations of State*
*Birch Murnaghan Equation of State*

### Lecture 4: Seismic Waves

The Wave equation
Attenuation
Reflection & refraction seismology
Rays, wave-fronts and the Huygens construction
Seismic anisotropy
Ray parameter

### Lecture 5: Earthquakes

Normal modes
Mohr circles
Magnitude and intensity
Locating an earthquake
Deep earthquakes
Focal mechanisms

### Lecture 6: Thermodynamics

Free energies
Heat capacity
Maxwell's relations
Internal energy
Enthalpy and entropy
Thermo-elastic coupling

### Lecture 7: The Deep Earth

Deep Earth mineral physics
Computational mineral physics
Phase changes
Inner core phase stability

### Lecture 8: Heat

Conduction equation
Simple geotherm
Diffusion and viscosity
Solution for a cooling dyke
Two-layer geotherm
Heat transfer in the core

### Lecture 9: Magnetism and the Core

The geodynamo
Poloidal and toroidal components

Magnetic reversals Time-dependant field

# Mathematical Requirements

Although most of this course is straightforward mathematically (e.g., simple algebra and trigonometry), there are some topics which require knowledge of higher level math's which may require extra private study; for example, differentiation and integration, total differentials, first and second order differential equations, 2nd and 4th order tensors, and a qualitative understanding of vector calculus. This is well within the capability of the geophysicists, and has all been covered to the level required in GEOL1006 Foundations of Physical Geoscience. Students will also be required to know MatLab, attending tutorials run by the Department in the first year.

# Reading List


W. Lowrie: *Fundamentals of Geophysics, Cambridge University Press, 2nd Edition, 2007.*

C. M. R. Fowler: *The Solid Earth: an introduction to global geophysics, Cambridge University Press, 1990.*

A. E. Mussett and M. A. Kahn: *Looking into the Earth: An introduction to geological geophysics, Cambridge University Press, 2000.*

G. C. Brown and A. E. Mussett: *The Inaccessible Earth: An integrated view to its structure and composition, Springer, 2nd Revised Edition, 1993.*

S. Stein and M. Wysession: *Introduction to Seismology, Earthquakes and Earth Structure, Wiley-Blackwell, 2002.*

D. L. Turcotte and G. Schubert: ***Geodynamics, Cambridge University Press***

J. P. Poirier: *Introduction to the Physics of the Earth's Interior, Cambridge University Press, 2nd Edition, 2000.*


*The image used on page 1 is a Landsat satellite image of Chesapeake Bay, USA taken on Oct 2 2009, Image Credit: U.S. Geological Survey, NASA.*

*The seismogram used on pages 2-5 is from a magnitude 9.1 earthquake on the 26th December 2004 in Sumatra, Indonesia.*

*[http://www.ga.gov.au/__data/assets/image/0005/26096/14-8754-Tsunami-figure4.jpg]*