

GEOL 30070: Geology for Civil Engineers

MODULE COORDINATOR: Prof. Frank McDermott

ADDITIONAL LECTURERS: Dr Laia Comas Bru
Prof. Stephen Daly
Prof. Peter Haughton
Assoc. Prof. Julian Menuge

CREDITS: 5

MODULE LEVEL: 3

SEMESTER: II

PRE-REQUISITES/PRIOR LEARNING:

No prior knowledge of geology is assumed but students should have some level of knowledge of the mechanics of solids.

OVERVIEW OF MODULE:

This module introduces the major rock types and geological processes that shape the Earth. It consists of lectures, practical classes and two half-day field classes. Igneous, sedimentary and metamorphic rocks, weathering and geomorphological processes are described. The practice of map-based geological interpretation is introduced. The application of Geology to Civil Engineering is analyzed in the context of engineering geology problems and solutions. The principles, methodologies and practices of geologically based site investigation are discussed in the context of examples and cases histories including slopes, dams/reservoirs and tunnels/caverns.

LEARNING OUTCOMES:

On completion of this module students should be able to:

1. Identify the major rock-forming minerals and rock types;
2. Describe and interpret the main geological features of common igneous, sedimentary and metamorphic rocks;
3. Interpret simple geological maps;
4. Collect a range of types of geological field data of relevance to engineering geology;
5. Assess the geological suitability of sites, predict likely geologically related problems and suggest reasonable geotechnical solutions.

ASSESSMENT:

Practical work: 40%
(Assessment of practical notebooks and practical examination)

Written Examination: 60%
(2 hr End of Semester examination on lecture content)

LECTURES:

Lecture 1: Mineralogy. (Assoc. Prof. J.F. Menuge)

Chemistry, structure and properties of some principal rock forming minerals and some common ore minerals. Engineering effects of mineral properties.

Lecture 2: Igneous Rocks. (Assoc. Prof. J.F. Menuge)

Varieties of formation, occurrence and structures. Chemistry, mineralogy and a simple classification based on these. Engineering properties of igneous rocks.

Lecture 3: Sedimentary Rocks 1. (Prof. P.D.W. Haughton)

Definition of clastic rocks, composition of clasts and matrix/cement, parameters for simple classification, depositional environments and sedimentary structures. Engineering properties of clastic sedimentary rocks.

Lecture 4: Sedimentary Rocks 2. (Prof. P.F. McDermott)

Non-clastic rocks. Carbonates. Distribution of modern carbonate sediments and depositional settings; range of skeletal components through geological time; mineralogy of carbonates; skeletal and non-skeletal allochems; cements and lime mud matrix; Folk and Dunham classification schemes; ancient and modern ramps and platforms, calciturbidites; dolomite, flint and chert; use of limestone as building stone.

Lecture 5: Large-Scale structures, Oil and Gas. *(Dr L. Comas Bru)*

The structure of the Earth. Earthquakes and their effects. Folds and faults. Petroleum sources, reservoirs and caps. Oil and gas exploration, development and production. Engineering aspects.

Lecture 6: Metamorphic Rocks. *(Prof. J.S. Daly)*

Metamorphic processes, chemistry and fluids. Relationship of metamorphism to deformation, (small-scale) structures e.g. folds, cleavage, joints, veins. Simple classifications. Engineering properties of metamorphic rocks.

Lecture 7: Weathering. *(Dr L. Comas Bru)*

Weathering mechanisms. Resistance and response of rocks to weathering. Chemistry and products of weathering and engineering problems. Soil formation and characteristics. Engineering properties of soils.

Lecture 8: Rivers and Coasts. *(Dr L. Comas Bru)*

Fluvial and coastal environments, processes and features. Engineering problems and solutions in fluvial and coastal regions.

Lecture 9: Engineering in glaciated regions. *(Dr L. Comas Bru)*

Glacial environments, processes and features. Engineering problems and solutions in glacial regions.

Lecture 10: Hydrogeology. *(Prof. P.D.W. Haughton)*

Groundwater cycles, water tables, aquifers, water wells and yield tests. Groundwater related engineering projects.

Lecture 11: Impacts of Climate Change – adaptation and resilience. *(Dr L. Comas Bru)*

Overview of climate change impacts and projections. Vulnerabilities of the energy, transport and water infrastructures systems to the effects of climate change. Interdependencies between systems. Engineers' role in the process of adaptation and resilience.

Lecture 12: Towards zero emissions. *(Dr L. Comas Bru)*

The 2015 Paris Agreement. Decarbonisation of the energy system in Ireland. Zero Emission Fossil fuel plants: Carbon Capture and Storage (CCS). Renewable energies. Energy efficiency and storage. Enhanced oil recovery. Carbon capture and storage (CCS): concept and challenges. Electricity storage.

Lecture 13: Engineering properties of rocks and site investigation. *(Dr L. Comas Bru)*

A simplified classification of rocks based on their engineering-relevant strengths and weaknesses. Aggregates. Importance of site investigation to the successful completion of an engineering project. Principal methods and problems.

Lecture 14: Slope processes and stability. *(Dr L. Comas Bru)*

Classification, geological controls, methods of prevention and containment, case histories.

Lecture 15: Foundations: engineering problems. *(Dr L. Comas Bru)*

Geological controls on differential subsidence. Geotechnical problems and foundation alternatives. Case studies.

Lecture 16: Dams and reservoirs. *(Dr L. Comas Bru)*

Geological controls on suitability of sites. Types of dams. Case histories illustrating problems and solutions.

Lecture 17: Tunnels and caverns. *(Dr L. Comas Bru)*

Geological control and geotechnical problems. Methods of tunnelling and tunnel support. Case histories illustrating problems and solutions.

PRACTICAL CLASSES

Practical 1: Common minerals and igneous rocks. *(Senior Postgraduate Demonstrator)*

Description and identification of common rock-forming minerals and igneous rocks. Examination of a range of common economic minerals. Examination of a variety of textures and structures commonly exhibited by igneous rocks.

Practical 2: Sedimentary Rocks. *(Senior Postgraduate Demonstrator)*

Description and identification of five clastic and five carbonate sedimentary rocks. Examination and identification of sedimentary structures and textures and their significance.

Practical 3: Metamorphic Rocks. *(Senior Postgraduate Demonstrator)*

Description and identification of seven common metamorphic rocks. Examination and identification of common metamorphic textures.

Practical 4: Reactive Minerals. *(Senior Postgraduate Demonstrator)*

Physical, chemical and biological weathering processes.

Practical 5: Geological Maps I: Introduction to geological maps. *(Senior Postgraduate Demonstrator)*

Introduction to topographic and structure contours. Horizontal and dipping strata. Construction of simple cross-sections.

Practical 6: Geological Maps II: Three point problems. *(Senior Postgraduate Demonstrator)*

Construction of structure contours from three outcrop/borehole data points in dipping strata to obtain complete outcrop pattern.

Practical 7: Geological Maps III: Unconformities. *(Senior Postgraduate Demonstrator)*

Construction of structure contours for beds below and above unconformities. Construction of cross-sections.

Practical 8: Geological Maps IV: Folds. *(Senior Postgraduate Demonstrator)*

Construction of structure contours for symmetrical folds with vertical fold axial planes. Identification of fold axial traces. Construction of cross-sections.

Practical 9: Geological Maps V: Faults. *(Senior Postgraduate Demonstrator)*

Normal and reverse faults. Dipping faults. Construction of structure contours and cross-sections in faulted and dipping strata.

Practical 10: Revision Practical. *(Senior Postgraduate Demonstrator)*

Revision and refreshing minerals, rocks and maps.

FIELD CLASSES:

Bray *(Prof. P.F. McDermott)*

Clastic sedimentary rocks. Structures and associated engineering problems and solutions on Bray Head.

Killiney *(Prof. J.S. Daly)*

Igneous and metamorphic rocks, glacial features, beach deposits and glacial till at Killiney. Tunnelling and dimension stone exercise. Site investigation using exposures. Slope stability and Neotectonics.