UAB
Universitat Autònoma de Barcelona

Structural Geology I

2026/2027

Code: 101047
Credits: 6

Degree programme	Type	Course
Geology	OB	3

Contact lecturer

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Teaching staff

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Group languages

You can consult this information at the end of the document.

Prerequisites

It is recommended to have passed the first-year subjects "Fonaments de Geologia" and "Treball de Camp de Geologia Regional" and taken the course "Geological Cartography"

Objectives

- Recognise and interpret the main brittle deformation structures, and their relationship with the tectonic settings.
- Provide a basic framework to interpret the machinal behaviour of rocks as function of physical parameters.
- Use the main techniques of the structural geology (map, cross-section, stereographic projection, sketch, etc) to process, interpret and graphical represent the structural data.
- Acquire and correctly communicate the structural information (oral, written and graphical)

Learning outcomes

- CM25 (Design studies on structural geological reservoirs for the storage of substances of economic interest.) Design studies on structural geological reservoirs for the storage of substances of economic interest.
- CM26 (Evaluate areas with seismic risk that affect the resident population, identifying the most vulnerable areas in contexts of geophysical work or urban planning.) Evaluate areas with seismic risk that affect the resident population, identifying the most vulnerable areas in contexts of geophysical work or urban planning.
- KM34 (Describe the physical principles that govern and condition the mechanical behaviour of different bodies and rock formations.) Describe the physical principles that govern and condition the mechanical

behaviour of different bodies and rock formations.
- KM35 (List the fundamental endogenous processes involved in the modification of relief due to brittle and ductile deformation.) List the fundamental endogenous processes involved in the modification of relief due to brittle and ductile deformation.
- KM36 (Identify the main current challenges of structural geology in the prevention and mitigation of geological risks.) Identify the main current challenges of structural geology in the prevention and mitigation of geological risks.
- SM30 (Use the specific instruments and techniques available to solve geometric problems related to folds, faults, shear zones and thrust faults.) Use the specific instruments and techniques available to solve geometric problems related to folds, faults, shear zones and thrust faults.
- SM31 (Use the different physical properties of geological materials to predict their mechanical and rheological behaviour under different types of stresses.) Use the different physical properties of geological materials to predict their mechanical and rheological behaviour under different types of stresses.
- SM32 (Analyse territorial planning considering geological evidence of seismic risk at local and regional scales.) Analyse territorial planning considering geological evidence of seismic risk at local and regional scales.

Contents

THEORY PROGRAM

Unit 1. STRUCTURAL GEOLOGY. Structural geology and tectonic: concepts, importance and scales of study. Fundamental deformation structures. Typology of structural data and structural analysis. Experimentation and modeling in Structural Geology.

Unit 2. STRESS. Concepts of force and stress. State of stress at a point. The stress tensor. The Mohr circle for stress. Medium stress, deviatoric and effective stresses. Hydrostatic and lithostatic stresses. Types of stress states. Measurement of stress. Stress fields. Tectonic stress. Stress patterns on a global scale.

Unit 3. DEFORMATION. Concepts of deformation and strain, its components. Homogeneous and heterogeneous deformation. Basic parameters of deformation in 1D, 2D and 3D.

Unit 4. RHEOLOGY. Relationships between stress and deformation. Elasticity, plasticity and viscosity: rheological models. The experimental deformation. Types of experiments and control parameters. The role of pressure, temperature, deformation rate and fluid pressure. Deformation by creep. Extrapolation of experimental data to natural conditions. Rheology of the lithosphere. The brittle-ductile transition.

Unit 5. BRITTLE DEFORMATION. Typology of the fractures developed in rocks subjected to stress. Shear fractures: Coulomb criterion and the Mohr envelope. Tension fractures. Theory and the Griffith criterion. Nucleation and propagation of fractures. Factors that influence fracturing. The frictional sliding. Beerley's Law. Reactivation of discontinuities. Influence of anisotropy. Mechanisms of brittle deformation. Deformation bands and fractures in porous rocks.

Unit 6. JOINTS. Growth and morphology of joints. The origin of joints. Propagation of joints into the regional stress field. Disposition of joints in relation to other structures.

Unit 7. FAULTS. Geometry of faults, displacement distribution. Formation and propagation of faults. Kinematic criteria. Fault anatomy (fault rocks). Faults and fluids (connectivity and sealing). Interpretation of the stress field from fractures.

Unit 8. THRUSTS. Terminology. Geometry of thrusts. Folds related to thrusts. Thrust systems and their evolution. Thrust emplacement. The Coulomb wedge model: its evolution. Gravitational models.

Unit 9. NORMAL FAULTS. Extensional faults: Geometry. Normal faults systems. Rift formation and metamorphic core complexes. Models of normal faults at crustal scale.

Unit 10. STRIKE SLIP FAULTS. Geometry of strike slip faults. Terminations of strike slip faults. Transfer and transform faults. Transcurrent faults. Transpression and transtension.

Unit 11. SALT TECTONICS. Properties and rheology of salt. Salt flow and parameters of control. Geometry of salt accumulations: structures related to salt diapirs. Salt diapirism in different tectonic regimes. The role of salt as a mechanically weak décollement.

Unit 12. SEISMICITY. The global distribution of earthquakes. Seismicity at plate and intraplate edges. Theoretical phases and mechanism of earthquakes. Magnitude and intensity. The seismic cycle, recurrence. Prediction of earthquakes and hazard analysis. Induced seismicity. Liquefaction.

PRACTICE PROGRAM

- LABORATORY

I. Force and stress. Concept of stress tensor and Mohr circle.

II. Stress Mohr circle. Calculation of the state of stress from "in-situ" measurements.

III. Experimental deformation. Obtention of the stress-deformation curve from experimental data: material properties.

IV. Interpretation of graphs on the rheology of materials. The role of pressure, temperature, fluids and deformation rate in the rheology of rocks.

V. The fracture envelope. The use of Mohr circles to study the formation of faults and fractures. Physical

parameters in the formation of fractures. Influence of the anisotropy in fracture development.

VI. Structures related to the displacement of thrusts and normal faults.

VII- VIII. Interpretation of geological maps and drawing of geological cross-sections.

IX. Analysis and interpretation of field data. Obtention of the stress field orientation from faults.

- FIELD WORK

Fault system of the Vallès-Penedès (1 day)

Fault recognition in the field and data collection. Kinematic criteria. Fault rocks. Interpretation of the structures and their representation in sketches and stereographic projections. Interpretation of the geodynamic context. Elaboration of a field report.

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Theory	23	0.92	CM25, CM26, KM34, KM35, KM36, SM30, SM31, SM32
Study, reading of bibliography and use of the Virtual Campus	32.5	1.3	CM26, KM35, KM36, SM30, SM31, SM32
Laboratory Practices	21	0.84	CM25, KM34, SM30, SM31
Field work	7	0.28	SM30, SM31
Treatment and interpretation of structural data and interpretation of geological maps	44.5	1.78	CM25, CM26, SM30, SM31, SM32

This subject consists of a theoretical part (23 hours), in which the topics will be explained, and some study guidelines will be given in order that the student can carry out the learning in an autonomous way. Occasionally there will be exercises to be carried out by the student autonomously.

The laboratory practices (21 hours) will be taught in sessions of 2 hours and their content will be closely related to the theory. The practices will consist of exercises, elaboration of graphs and interpretation of experimental and field data, as well as the reading and interpretation of geological maps at different scales.
This work will be done by the student under supervision. The work not completed during the practice session, will have to be completed autonomously by the student. Occasionally the exercises will be collected to be corrected and evaluated.

The field work will consist of a day trip to study the Vallès-Penedès fault system. Attendance at the field trip is

mandatory to pass the subject. Before the practice, the students will elaborate autonomously a summary based on bibliography, on the location and main structural elements of the zone.
The field work will consist in the observation and explanation of several outcrops, followed by data collection by the students. Subsequently, there will be a laboratory practical session to interpret the field data and provide guidelines for the preparation of the field report.

For this subject, the use of Artificial Intelligence (AI) technologies is permitted exclusively for support tasks (i.e., bibliographic or information search, text summarization, comparison of readings, text correction, translations). Students must clearly identify which parts have been generated with this technology, specify the tools used, and include a critical reflection on how these have influenced the process and the final result of the activity. The lack of transparency in the use of AI in this assessable activitywill be considered academic fault and may result in partial or total penalties in the grade of this subject, or more severe sanctions in serious cases.

Annotation: within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Exercises in class	5%	1	0.04	SM30, SM31
Correction of practical exercises	15%	1	0.04	CM25, KM34, SM30, SM31
Examination to recover the first and/or second exams	máx. 60%	3	0.12	CM25, CM26, KM34, KM35, KM36, SM30, SM31, SM32
Field Work Memory	20%	11	0.44	SM30, SM31
First partial exam of theoretical and practical contents	30%	3	0.12	CM25, CM26, KM34, KM35, KM36, SM30, SM31, SM32
Second partial exam of theoretical and practical contents	30%	3	0.12	CM25, CM26, KM34, KM35, KM36, SM30, SM31, SM32

Degree of compulsory nature of face-to-face teaching

In order for a student to be evaluated, the following minimum requirements must be met:

- Attend to the 80% of the theoretical sessions

- Attend to the 80% of the laboratory practices.

- Attend to the field trip.

Evaluation

Two partial exams of theoretical and practical content will be carried out. The evaluation will be completed with the evaluation of the other activities in the manner indicated below.

Assessment system for the acquisition of skills and qualifications system:

- Evaluation of laboratory practices by presenting a dossier (15%)

- Practical exercises in class (5%)

- Evaluation of a fieldwork report (20%)

- Partial and final exams based on the theoretical and practical contents (60%)

Only the activities evaluated through partial exams are recoverable. Students must take the exam for all those activities not passed during the course. The recovery will be made through an examination.

If a student has carried out evaluation activities that exceed 35% of the total of the subject, he / she could not be graded as NOT PRESENTED.

Single evaluation

The assesment of the course will be done by means of a theorical exam (25%), practical problem exam (35%), submission of the laboratory-practical dossier (15%) and the field trip report (25%). The last two activities are not recoverable during the final reavaluation exam.

Bibliography

Reference textbook:

Fossen, H. 2016. *Structural Geology (2nd edition).* Cambridge University Press. Edimburg. 463 pp. https://doi.org/10.1017/9781107415096 (Digital and hardback format)

Additional bibliography:

Allmendinger, R. W. Modern Structural Practice (online, https://www.rickallmendinger.net/download).

Bastida, F. 2005. *Geología. Una visión moderna de las Ciencias de la Tierra (vol.2).*Edic. Trea. Gijón.

Davis, G.H., Reynolds, S.J. and Kluth, C.F. 2012. *Structural geology of rocks and regions*. 3rd ed. New York: John Wiley & Sons. 864 pp.

Hatcher, R.D. 1990. *Structural Geology*. Merrill Publishing Co. Columbus. 531 pp.

Hobbs, B.E., Means, W.D. & Williams P.F. 1981. *Geología Estructural*. Omega. Barcelona. 518 pp.

Twiss, R.J. & Moores, E. M. 1992. *Structural Geology.* W.H. Freeman and Co. New York. 532 pp.

Van der Pluijm, B.A. & Marshak, S. 1997. *Earth Structure, An introduction to Structural Geology and Tectonics* .WCB/McGraw-Hill. 495 pp.

Software

Stereonet (free online, https://www.rickallmendinger.net/stereonet)

MohrPlotter3 (free online, https://www.rickallmendinger.net/mohrplotter)

Google Earth Pro (desktop version)

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this link. To access the information, you will need to enter the course CODE

Type of teaching	Group	Language	Semester	Shift
(TE) Theory	1	Catalan/Spanish	first semester	morning-mixed
(PLAB) Practical laboratories	1	Catalan/Spanish	first semester	morning-mixed
(PCAM) Field practices	1	Catalan/Spanish	first semester	morning-mixed
(PLAB) Practical laboratories	2	Catalan/Spanish	first semester	morning-mixed
(PCAM) Field practices	2	Catalan/Spanish	first semester	morning-mixed
(PLAB) Practical laboratories	3	Catalan/Spanish	first semester	morning-mixed