

Academic Year/course: 2022/23

26442 - Tectonics: Basins and Orogens

Syllabus Information

Academic Year: 2022/23

Subject: 26442 - Tectonics: Basins and Orogens

Faculty / School: 100 - Facultad de Ciencias

Degree: 296 - Degree in Geology
588 - Degree in Geology

ECTS: 5.0

Year: 4

Semester: Second semester

Subject Type: Optional

Module:

1. General information

1.1. Aims of the course

The expected results of the course respond to the following general aims

- 1- To provide advanced knowledge about the processes by which the deformation of the earth's crust occurs at regional scale.
- 2- To interpret the tectonic structures observed in terms of these processes.
- 3- To make accurate and precise cross-sections from the geometric point of view in different structural domains.
- 4- To introduce and apply the basic techniques of restoration of geological cross sections.
- 5- To incorporate geophysical data to interpret cross-sections in deep.
- 6- Introduce the basic techniques of analogue modelling of tectonic processes.
- 7- To understand in the field the structural features of a basin and / or chain.

These approaches and objectives are aligned with the following Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (<https://www.un.org/sustainabledevelopment/es/>): Goal 4: Quality education.

1.2. Context and importance of this course in the degree

This course is part of a group of subjects of the *Degree in Geology* that constitute the necessary training for those students who want a complete training in Geodynamics and Structural Geology.

1.3. Recommendations to take this course

It is highly recommended to pass the modules of Structural Geology and Global Geophysics (or have similar training) in previous years.

2. Learning goals

2.1. Competences

After completing the course, the student will be competent in the following skills:

- To recognize the different structural styles in the Earth's crust .
- To understand the Earth's crust deformational processes at regional scale.
- To manage Spanish and English literature on evolution of orogens, basins and intraplate deformation.
- To analyze, synthesize and summarize specialized texts on evolution of orogens, basins and intraplate deformation.
- To properly communicate written, oral and graphical scientific content.
- To use the methods of geometric reconstruction of geological cross-sections.
- To manage restoration techniques of geological cross-sections.

- To construct correct geological cross-sections in regions with different structural styles.
- To construct deep geological cross-sections using geophysical data.
- To manage the basic techniques of experimental tectonics.
- To identify the structural features of a basin and / or orogen in the field.
- To collect structural data in the field and integrate them into a general cross section of an area.

2.2. Learning goals

The student, in order to pass the course, will have to show her/his competence in the following skills:

1. Understanding of the Earth crust deformational processes at regional scale.
2. Ability to interpret the tectonic structures observed in terms of those processes.
3. Ability to construct correct geological cross-sections from the geometric point of view and respecting the structural style of the area.
4. Knowledge and application of the basic techniques of restoration of geological sections.
5. Knowledge of the fundamentals and basic techniques of analogue modelling of tectonic processes.
6. Competence in the management of Castilian and English literature on evolution of orogens, basins and intraplate deformation.

2.3. Importance of learning goals

The correct execution of geological cross-sections combined with geological mapping constitute the usual work in structural geology and tectonics, as a tool to unravel the structure of a region and as a basis for the development of many applied works.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The student will prove that he/she has achieved the expected learning results by means of the following assessment tasks:

Continuous assessment:

1. Resolution of 2 questionnaires and autonomous work on reading and commenting a scientific paper written in English (35%).
2. Course work about practice sessions (45%).
3. Report of the results of the fieldwork (20%).

Global assessment:

Written theoretical exam (40%).

Written practical exam (40%).

Report of the field excursion (20%). If justified, it could be replaced by an exam on the structure and tectonic evolution of the Pyrenees.

Both in continuous and global assessment, it will be necessary to obtain a 50% mark for each assessment part.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, such as lectures, practice sessions, laboratory sessions, fieldwork, seminars and tutorials.

4.2. Learning tasks

This course is organized as follows:

- **Lectures** (15 hours). 2 weekly hours. The students will have lecture-notes given by the professor as the basis for their learning, but they must extend the information given in class using sources such as technical books and scientific journals.
- **Seminars** (2 hours). 2 sessions in one weekly hour.
- **Practice sessions** (20 hours) 10 sessions in two weekly hours. Construction of geological cross-sections in different geodynamic contexts. Students are provided with tasks guidelines for each practice session.

- **Laboratory sessions** (3 hours)(3 h/week, 1 session): construction of an analogue model of the formation of a fold and thrust belt.
- **Fieldwork** (10 hours) Two trips: a complete transect of and orogen (the Pyrenees).
- **Tutorials.** will be considered another academic activity where the student will be free to ask doubts related with the subject.

Teaching and assessment activities will be carried out on site for as long and as much as possible. This scenario could change if safety regulations related to the covid19 crisis recommended online activities.

4.3. Syllabus

This course will address the following topics:

Lectures

- **Topic 1.** Convergent tectonic regimes. Subduction. Island arcs and orogens. Structure of accretionary complex. The back-arc region. Thermal structure and melting at subduction zones.
- **Topic 2.** Collision and obduction. The collision process. Gravitational post-orogenic collapse. The Himalayas. Models of emplacement of ophiolitic complex.
- **Topic 3.** Anatomy of orogenic belts. The foreland basin, the fold-and-thrust belt, and the crystalline core zone. The Alpine orogenic belt.
- **Topic 4.** The European Hercynian orogen. The Caledonian orogenic belt. Orogeny in the Precambrian. Archean tectonics.
- **Topic 5.** Thrust tectonics. Terminology of fold-thrust belts. Fault-related folds. Kink vs. concentric fold styles.
- **Topic 6.** Growth strata. Fold analysis from growth strata. Principles of cross-section balancing. Reference lines. Concept of a balanced cross section. Area balance and bed-length balance.
- **Topic 7.** Experimental tectonics. Principles of analogue modelling. Dimensioning. Materials and experimental settings.
- **Topic 8.** Transform faults, strike-slip faults, and related fracture zones. Transpression and transtension. San Andreas fault and the Alpine Fault of New Zealand.
- **Topic 9.** Divergent tectonic regimes. Ocean ridges and continental rifts. The Afro-Arabian rift system. Doming and rifting. Pure shear and simple shear. Aulacogens and passive margins. The salt walls of the Atlantic passive margins. Salt tectonics.
- **Topic 10.** Structures associated with extensional regime. Normal fault systems, listric faults. Kinematic models. Metamorphic core complexes. Continental extensional provinces at convergent boundaries. The Basin-and-Range province.
- **Topic 11.** Intraplate tectonic regimes. Intraplate extensional basins. Mesozoic European rift-system. The Rhine rift. Basement uplifts. The Laramide Rocky Mountains. Thick-skinned tectonic.
- **Topic 12.** Inversion tectonics. Positive and negative inversion tectonics. Terminology. Degree of inversion, the null point. Stress raisers and buttressing. Tectonic inversion without structural inversion. Reactivation and new formation of faults.
- **Topic 13.** Lower structural level. Syn-cleavage folding and intersection lineation. Foliations and stretching lineations. Superposed folding. Migmatitic domes and plutons.
- **Topic 14.** Active tectonics, Neotectonics and Seismotectonics. Direct measurements of tectonic movements. Geologic-Geomorphologic features. Neotectonic behaviour of faults.

Practice sessions

1. Cross section and profile construction: The Busk and the Kink constructions.
2. Geometry of thrusts. Drawing a deformed-state cross-section.
3. Restoring a cross section, restoration based on bed-length balance. Evaluating and improving a cross section.
4. Cross sections in areas affected by complex thrust systems.
5. Analogue modelling of a fold and thrust belt (3h - laboratory).
6. Cross sections in areas affected by extensional tectonics.
7. Cross sections in areas affected by thick-skin tectonics incorporating geophysical information.
8. Cross sections in areas affected by inversion tectonics.
9. Cross sections in areas affected by syn-cleavage and superposed folding.

Survey

- 2 days of fieldwork: two days of work making a complete transect of an orogen; the Pyrenees: South-Pyrenean Zone, Axial Zone, North-Pyrenean Zone (in late May, with overnight in Canfranc-Station).

4.4. Course planning and calendar

Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course will be provided on the first day of class or please refer to the Faculty of Sciences website (<https://ciencias.unizar.es>; <https://cienciasierra.unizar.es>) and Moodle.

4.5. Bibliography and recommended resources

<http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=26442>