26442 - Tectonics: Basins and Orogens

Información del Plan Docente

Academic Year	2017/18
Faculty / School	100 - Facultad de Ciencias
Degree	296 - Degree in Geology
ECTS	5.0
Year	4
Semester	Second semester
Subject Type	Optional
Module	---

1.General information

1.1.Introduction

Brief presentation of the course

The aim of this module is to introduce the main structural styles that can be found in the Earth's crust at regional scale, depending on the type of rock, the conditions of pressure and temperature during deformation, and the tectonic regime. This module incorporates information obtained from geophysical data helping to determine the geometry of large structures at depth.

1.2.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.

1.3.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.

1.4.Activities and key dates

Beginning of the course: beginning of the second semester according to the academic calendar established by the Faculty of Sciences and published on its website.

Timetable: according to the schedule established by the Faculty of Sciences and published on its website.

2.Learning goals

2.1.Learning goals

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

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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.

2.2.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.Aims of the course and competences

3.1.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.

3.2.Competences

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

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- 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.

4.Assessment (1st and 2nd call)

4.1.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 3 questionnaires and personal working on reading and commenting a scientific paper written in English (35%).

2. Laboratory sessions (35%).

3. Report of the results of the fieldwork (30%).

Overall assessment :

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Written theoretical-practical exam (100%).

5.Methodology, learning tasks, syllabus and resources

5.1.Methodological overview

The learning process that has been designed for this course is based on the following activities:

The students will have class-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.

The 5 ECTS of this subject correspond to 50 hours of classroom education, which will be arranged in 15 hours of theoretical courses, 19 hours of laboratory sessions and 16 hours of fieldwork.

The tutorials will be considered another academic activity where the student will be free to ask doubts related with the subject.

5.2.Learning tasks

The programme offered to the students to help them achieve the learning results includes the following activities:

- 12 hours of theoretical classes (2 h/week).

- 3 hours of seminars.

- 16 hours of lab sessions (2 h/week, 8 sessions): construction of geological cross-sections in different geodynamic contexts.

- 3 hours of lab sessions (3 h/week, 1 session): construction of an analogue model of the formation of a fold and thrust belt.

- 16 hours of field-work (2 days): a complete transect of and orogen (the Pyrenees).

5.3.Syllabus

Contents/Lectures:

1. Convergent tectonic regimes. Subduction. Island arcs and orogens. Structure of accretionary complex. The back-arc region. Thermal structure and melting at subduction zones.

2. Collision and obduction. The collision process. Gravitational post-orogenic collapse. The Himalayas. Models of emplacement of ophiolitic complex.

3. Anatomy of orogenic belts. The foreland basin, the fold-and-thrust belt, and the crystalline core zone. The Alpine

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orogenic belt.

4. The European Hercynian orogen. The Caledonian orogenic belt. Orogeny in the Precambrian. Archean tectonics.

5. Thrust tectonics. Terminology of fold-thrust belts. Fault-related folds. Kink *vs.* concentric fold styles.

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.

7. Experimental tectonics. Principles of analogue modelling. Dimensioning. Materials and experimental settings.

8. Transform faults, strike-slip faults, and related fracture zones. Transpression and transtension. San Andreas fault and the Alpine Fault of New Zealand.

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.

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.

11. Intraplate tectonic regimes. Intraplate extensional basins. Mesozoic European rift-system. The Rhine rift. Basement uplifts. The Laramide Rocky Mountains. Thick-skinned tectonic.

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.

13. Lower structural level. Syn-cleavage folding and intersection lineation. Foliations and stretching lineations. Superposed folding. Migmatitic domes and plutons.

14. Active tectonics, Neotectonics and Seismotectonics. Direct measurements of tectonic movements. Geologic-Geomorphologic features. Neotectonic behaviour of faults.

Practical/Problems:

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.

Practical/Survey:

2 days of fieldwork: two work days 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).

5.4.Course planning and calendar

	Monday	**Tuesday**	**W**	**Thursday**	**Friday**
Week 1	Presentation of the course				
Week 2	Distribution questionnaire-1/ Theoretical class	Theoretical class Practical session-1			
Week 3	Theoretical class	Theoretical class Practical session-2			
Week 4	Theoretical class	Seminar-1 Practical session-3			

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Week 5	Questionnaire-2/ Theoretical class	Theoretical class Practical session-4			
Week 6	Theoretical class	Theoretical class Practical session-5 (3 h) Analogue modelling			
Week 7	Theoretical class	Seminar-2 Practical session-6			
Week 8	Questionnaire-3/ Theoretical class	Theoretical class Practical session-7			
Week 9	Theoretical class	Theoretical class Practical session-8			
Week 10	Theoretical class	Seminar-3 Practical session-9			
Week 11					
Week 12					
Week 13					

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Week 14				Transect Pyrenees

5.5.Bibliography and recommended resources

BB	Basic methods of structural geology. Part I, Elementary techniques / by Stephen Marshak, Gautam Mitra. Part II, Special topics. Englewood Cliffs, New Jersey : Prentice Hall, cop. 1988
BB	Choukroune, Pierre. Déformations et déplacements dans la croà»te terrestre / Pierre Choukroune ; Ouvrage publié avec le concurs du ministère de l'Enseignement supérieur et de la Recherche (Direction de l'information scientifique et technique et des bibliothèques) Paris[etc.] : Masson, 1995
BB	Debelmas, Jacques. Les grandes structures géologiques / Jacques Debelmas, Georges Mascle . - 2e éd. rev. et corr. Paris [etc.] : Masson, 1994
BB	Hancock, P.L. (ed.). Continental deformation. Pergamon Press, 1994
BB	J Vergés, M Marzo, J.A Muñoz (2002) Growth strata in foreland settings. Sedimentary geology 146(1-2), pp. 1-9. En: Sedimentary geology Amsterdam : Elsevier, 1967- [Publicación periódica]
BB	Kearey, Philip. Global tectonics / Philip Kearey, Frederick J. Vine . - 3rd ed. Oxford [etc.] : Blackwell Science, 2008
BB	Mattauer, Maurice. Las deformaciones de los materiales de la corteza terrestre / Maurice Mattauer ; [traducido por Mateo Gutiérrez Elorza y Jesús Aguado Sánchez] . - [2a ed.] Barcelona : Omega, D.L. 1989
BB	McClay, Ken. Thrust Tectonics. HarperCollins Publishers, 1991
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BB	Park, R.G.. Geological structures and moving plates / R.G. Park . - 1st ed. reimp. Glasgow [etc.] : Blackie, 1993
BB	Van der Pluijm, Ben A.. Earth structure : an introduction to structural geology and tectonics / Ben A. van der Pluijm, Stephen Marshak ; with contributions by Richard W. Allmendinger...[et al.] . 2nd ed. New York ; London : W.W. Norton & Company, cop. 2004
BC	Cooper, M. A. & Williams, G. D. (eds.). Inversion Tectonics. Geolical Society of America, 1989
BC	Coward, M.P., Dewey J. F. & Hancock, P. L. (eds.). Continental Extensional Tectonics. Geological Society, 1987
BC	Ramberg, Hans. Gravity, Deformation and the Earth's Crust : in theory, experiments and geological application . Academic Press, 1981
BC	Schmidt, C. J., Chase, R. B. & Erslev, E. A. (eds.). Laramide basement deformation in the Rocky Mountain Foreland of the Western United States. Geological Society of America, 1993
BC	Soto Marín, Ruth. Estructuras oblicuas : modelización analógica y ejemplos de la zona surpirenaica / Ruth Soto Marín [Zaragoza] : Ruth Soto Marín, [2002]

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Gratier, J.P. (coord.) (1988). L'équilibrage des coupes géologiques. Mem. et Doc. du CAESS, 20, 157 pp. - [http://hal-insu.archives-ouvertes.fr/docs/00/64/88/43/PDF/Grattier.pdf]

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