Universidad Zaragoza

Academic Year/course: 2022/23

60384 - Integrated basin analysis

Syllabus Information

Academic Year: 2022/23
Subject: 60384 - Integrated basin analysis
Faculty / School: 100 - Facultad de Ciencias
Degree: 624 - Master's in Geology: Techniques and Applications
ECTS: 6.0
Year: 1
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 (a) the main stratigraphic and tectonic features of extensional and compressional sedimentary basins in different geodynamic contexts, (b) the different tectonic models generating sedimentary basins in both extensional and compressional tectonics, (c) the magmatism related to extensional/transtensional or compressional/transpressional context where basins develop, (d) the physical and chemical techniques of particular minerals used for reconstructing the evolution of sedimentary basins, and (e) the hydrogeological models of great sedimentary basins.

2. To introduce and apply the basic techniques of (a) data acquisition in order to characterize the sedimentary record and its palaeoenvironmental evolution and to reconstruct the geometry of contemporary tectonics structures, evaluating their role on geometry and distribution of sedimentary facies, (b) analysis of palaeomagnetic data for regional tectonic studies, and (c) analogue modelling for the study of formation and inversion of sedimentary basins.

The general objectives:
- Know the main stratigraphic and tectonic features of sedimentary basins (extensional and compressive).
- Manage the different methodologies for data acquisition and characterization of the sedimentary fill, the reconstruction of palaeoenvironments and their relationship with contemporary tectonic structures (both in terms of geometric and sedimentary units).
- Know the effects of tectonic activity in the sedimentary fill and the sedimentary models developed in different structural contexts.
- Know the different tectonic models generated by sedimentary basins and the geodynamic framework in which are framed.
- Have the ability to handle basic paleomagnetic data analysis programs in the study of tectonics regional.
- Know and handle the main analog modeling techniques applied to the study of training and investment of basins.
- Know the main physicochemical techniques to reconstruct the evolution of basins.
- Know the hydrogeological models developed for large basins.
- Understand and be able to determine the relative importance of the geological processes that control the formation and evolution of sedimentary basins

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/), in such a way that the acquisition of the results of Learning the subject provides training and competence to contribute to a certain extent to its achievement: Goal 4: Quality education (targets 4.3 and 4.4), Goal 9: Infrastructure (target 9.2) and Goal 12: Responsible consumption and production (target 12.2).

1.2. Context and importance of this course in the degree

This course is part of a group of subjects of the that constitute the *Master in Geology: Techniques and Applications*

necessary training for those students who want to understand the formation and evolution of sedimentary basins and to develop skills for their study. Due to this subject enables the better understanding of sedimentary basins, it is essential and complementary to other applied subjects of the Master degree as, for example, *Subsurface Geology* or *Geological Storages*.

1.3. Recommendations to take this course

This course, which is focused to acquire advanced training in basin analysis integrating different methods and techniques, is intended for students with a general background in Geology, particularly in Stratigraphy, Sedimentary Processes and Environments, Structural Geology, Tectonics, Geophysics and Sedimentary and Igneous Petrology.

For a better advantage of the course the students are encouraged to continuous attend the theoretical and practical sessions, which are strongly interconnected.

2. Learning goals

2.1. Competences

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

1. The integration of the main factors (tectonic, structural, stratigraphic, sedimentary, geophysical, palaeontological, hydrogeological, diagenetic, metamorphic and igneous) controlling formation and development of sedimentary basins.

2. The acquisition of data in the field surveys, their analysis and their interpretation.

3. The planning, organization, realization and exposition of the research on experimental modelling of tectonic processes, particularly for formation and evolution of sedimentary basins.

4. The integration of several types of evidence to formulate and to prove hypothesis on the formation and evolution of basins.

5. The interpretation of magnetic fabric and palaeomagnetic data and their application to studies on regional tectonics and structural geology.

2.2. Learning goals

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

- Understand the main stratigraphical and tectonic features of extensional and compressional sedimentary basins.

- Knowledge and apply the distinct techniques to characterize the sedimentary infill and the palaeoenvironmental reconstructionand their relationships with contemporary tectonic structures.

- Knowledge the effects of the tectonic activity on the sedimentary infill of a basin and the sedimentary models developed indifferent tectonic contexts.

- Knowledge the main tectonic models generating sedimentary basins depending on the geodynamic context.

- Ability to handle the basic programs of palaeomagnetic data analysis used for regional tectonic studies, and the basic techniques for magnetic fabric and palaeomagnetic data interpretation and their application in tectonics and magnetostratigraphy.

- Knowledge and apply techniques in analogue modelling for studying tectonic processes and to interpret the modelling results.

- Knowledge the main physical-chemical techniques applied for reconstructing the evolution of sedimentary basins.

- Knowledge the hydrogeological models operating in great sedimentary basins.

- Understand the relative role of the main geological processes controlling the formation and evolution of the sedimentary basins.

2.3. Importance of learning goals

The integrated analysis of sedimentary basins is an important research field in Geology from the scientific and applied plain. The combined use of methodologies coming from distinct branch of the Geology for the study of sedimentary basins is relatively recent and is still in continuous development. From an applied point of view, the integrated analysis allows the reconstruction of the 3D stratigraphic and structural architecture of sedimentary basins, which is of special relevance for the characterization of sedimentary units as reservoirs or geological storages, and consequently for the evaluation of possible geological resources (e.g., oil, gas, water, mineral...). Accordingly, students that course and acquire the competences of this subject will be more able to develop scientific research on sedimentary basins and they can opt to continue their work in applied research in branches so important as the Petroleum geology or the Geological storage of CO2. In addition, this course foments the analysis and discussion of the results as a way to propose reasoned interpretations, which is desirable for both scientific and applied purposes.

3. Assessment (1st and 2nd call)

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

I. Assessment tasks

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

(a) Continuous assessment

To track the improvement and knowledge of the students, the assessment will be carried out during the learning process based on:

a.1) Evaluation of *theoretical-practical questionnaires* for writing answers. Each questionnaire will be evaluated from 0 to 10, but they could have different relative value. The evaluations of each questionnaire will be indicated in the first class of the subject. The final punctuation will be obtained from the weighted mean (after the relative value of each one) of the obtained evaluations.

a.2) Evaluation of a personal and individual *practica work* in which the results of the practical activities carried out during the practical workcourse on a sedimentary basin (fieldwork, photogeological analysis, analysis and interpretation of data inlaboratory/computer) will be presented and discussed. This report(s) must have a final section with the interpretation and discussion of the main results and the relevant conclusions of the investigated sedimentary basin. This activity will be evaluated from 0 to 10.

(b) Global assessment

Students that did no follow the course, and those that following it wish therefore it, could be evaluated with a global test of evaluation, which will consist of a written theoretical-practical exam of the assembly of the course contents (evaluated from 0 to 10).

II. Assessment criteria

(a) Continuous assessment

The student must demonstrate that has achieved the intended background through attendance, individual responses to questionnaires and individual resolution of problems presented in practices. The final mark includes: i) Response to theoretical-practical *questionnaires* (70%) and ii) Report of *practical* sessions (30%).

(b) Global assessment

Written theoretical-practical exam (100%).

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course is oriented towards achievement of the learning objectives. The 6 ECTS of this course correspond to 60 hours of classroom activities, which will be arranged in 25 hours of lectures, 13 hours of problems and cases, 8 hours of laboratory sessions, and 14 hours of fieldwork (two trips). Classroom materials will be available via Moodle. These include a repository of the lecture notes used in class, the course syllabus, as well as other course-specific learning materials. The students will have class-notes given by the professor as the basis of their learning, but they must extend the information given in class using sources such as technical books and scientific journals. In most of the practice sessions, the work is developed in a specific extensional basin, so that the learning process is based on a practical case. The tutorials will be considered another academic activity where the student will be free to ask doubts related with the course. Students are expected to participate actively in the class throughout the semester. Further information regarding the course will be provided on the first day of class.

4.2. Learning tasks

The 6 ECTS course includes the following learning tasks:

Activity I. **Lectures** (2.5 ECTS: 25 hours). They have the purpose of providing advanced knowledge about the main topics of the course.

Activity II. **Practice sessions** (1.3 ECTS: 13 hours). They include the solving of problems and cases, including some work with the computer.

Activity III. **Laboratory practice** (0.8 ECTS: 8 hours). They include the development of experiments (modelling) and photogeology analysis (with stereoscopy) in the laboratory.

Activity IV. **Field work** (1.4 ECTS, two trips: 14 hours). They have the purpose of applying the techniques of data acquisition and observations of sedimentary and structural features of sedimentary basins.

Activity V. **Tutorials**. Answering doubts generated during the course by the corresponding lectures.

The teaching and assessment activities will be carried out on-site (face-to-face) unless, due to the exceptional health situation, the provisions issued by the competent authorities and by the University of Zaragoza provide for them to be carried out off-site (telematically), except for field practices.

4.3. Syllabus

The course will address the following topics:

(a) Lectures

Section I. Introduction

Topic 1. Main types of extensional basins and in compression regime.

Topic 2. Subsidence and isostasis.

Topic 3. Controls on the genesis, evolution and filling of the basins: tectonics and climate.
Topic 4. Accommodation and sediment supply.
Topic 5. The basin filling and the genetic units.

Section II. Integrated study of extensional basins (rift basins)
Topic 6. Classifications and geometric characteristics of the sedimentary fill.
Topic 7. Sedimentary models.
Topic 8. Initiation and evolution of rifts.
Topic 9. Normal fault tectonics. Restitution and validation of cross-sections.
Topic 10. Tectonic-sedimentation relationships, sinsedimentary faults and other deformation structures.
Topic 11. Magmatism in extensional / transtensional basins.

Section III. Integrated study of compression basins (foreland basins)
Topic 12. Foreland basins (forelands). Types and evolutionary context. Geometric and sedimentary characteristics.
Topic 13. Phases of the filling of a foreland basin and discontinuities.
Topic 14. Inversion tectonics and compressive tectonics. Tectonic-sedimentation relationships in non-inversion basins and com
Topic 15. Magmatism in compressive / transpressive basins.

Section IV. Other methodologies in the study of basins
Topic 16. Experimental tectonics. Analogue models of sedimentary basin formation.
Topic 17. Biostratigraphic dating and paleoenvironmental reconstruction in basin analysis.
Topic 18. Magnetostratigraphy and magnetotectonics.
Topic 19. Physico-chemical techniques applied to the study of the evolution of basins.
Topic 20. Hydrogeological models in large sedimentary basins.

(b) Practice sessions (Cabinet / Computer / Lab Practice)
1. Stratigraphic correlation (Ca).
2. Analysis of geometric devices in extensional basins from photogeology and satellite images (Lab).
3. Stratigraphic-structural correlation (Ca).
4. Construction of subsidence curves and geohistory with specific software (Co).
5. Analog modeling of the formation of a basin (Lab).
6. Reconstruction of the fault geometry in depth (Ca).
7. Restitution of geological cross-sections (area-depth method) and analysis of fault activity (Ca).
8. Chronostratigraphic panels and interpretation of genetic units (Ca).
9. Analysis of geometric devices in compression basins from photogeology (Lab).
10. Analysis of paleomagnetic data in the study of basins and regional tectonics (Co).

(c) Field practice
2 field trips for data collection and study of the tectonic-sedimentation relationships: One in an extensional basin (eg Cretaceou

4.4. Course planning and calendar

This course is a second semester course. Classes will start the first academic week.

Students can refer to the Faculty of Sciences and Earth Sciences Department websites for timetable, classroom or assessment dates.

Further information regarding this course (examination, calendar,...), will be provided on the first day of class.

Dates for each field trip will be published at the Earth Sciences Department website.

Tutorials: Office hours will be also provided the first day of class.

The dates for submission the questionnaires and practical reports will be indicated by the corresponding professor.

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=60384