Universidad Zaragoza

Academic Year/course: 2021/22

60375 - Methods and techniques in Geology

Syllabus Information

Academic Year: 2021/22
Subject: 60375 - Methods and techniques in Geology
Faculty / School: 100 - Facultad de Ciencias
Degree: 624 - Master's in Geology: Techniques and Applications
ECTS: 9.0
Year: 1
Semester: First semester
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

The course and its expected results respond to the following approaches and objectives:

The course provides a fundamental basis for students who want to pursue studies in any field of Geology as it shows a very complete spectrum of the most common techniques used in Mineralogy , Petrology / Petrophysics and Geochemistry, Stratigraphy and Sedimentology, Paleontology, Structural Geology and Geophysics, Geomorphology and Hydrogeology, and its various applications. The development of any basic or applied research activity in Geology, aimed at obtaining detailed information that may be the subject of advanced studies or the realization of models of geological processes and systems, requires:
1- Have a broad knowledge of the techniques and methods that can be applied to achieve the intended objectives.

2- Know the application requirements of each technique and assess the costs and associated procedures in each case.

3- Assess what results can be obtained by each technique or procedure and with what degree of precision.

4- Design a work plan to obtain the necessary information.

The aim of this course is to cover these four objectives, covering the widest possible spectrum of techniques and work themes, familiarizing the student with sampling techniques, laboratory analysis and interpretation of geological data. The student, regardless of their future prospects, acquires a broad and integrated vision of the techniques and methods currently available, in order to adapt them to their future needs and to design a work plan tailored to the requirements and limitations of each specific case.

These approaches and objectives are intended to be technological tools in the field of natural sciences that collaborate with the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (https://www.un.org/sustainabledevelopment/es/), of such that the acquisition of the learning results of the subject provides training and competence to contribute to a certain extent to its achievement.

1.2. Context and importance of this course in the degree

This subject, together with those of "Treatment, representation and modeling of geological data" and "Scientific and technical communication", constitute the group of compulsory subjects of the degree (all of them taught in the first semester), with a marked transversal character and basic for the development of the contents of the subjects of the second semester of the degree. In this subject it is intended that the student acquire a broad knowledge of the different techniques and methods used in Geology.

1.3. Recommendations to take this course

This course is aimed at students who want to acquire advanced training in the different methods and study techniques of Geology, both for basic and applied research purposes.

This course consists of two modules:

MODULE 1: Instrumental techniques: requirements and applications (4.4 ECTS)

MODULE 2: Dating of geological materials (4.6 ECTS)

Since the programming of the subject includes a broad agenda and the face-to-face sessions have a theoretical-practical character, it is recommended a dynamics of continuous work, that allows to progress adequately in the subject and to complete the questionnaires or evaluation exercises that allow to verify the acquisition of the competences during the development of the subject.

2. Learning goals

2.1. Competences

Upon passing the subject, the student will be more competent to ...

- Have knowledge that provides a basis for being original in the development and application of ideas, often in a research context.

- Apply the acquired knowledge and be able to solve problems in new or little-known environments within broader (or multidisciplinary) contexts related to their area of study.

- Integrate knowledge and face the complexity of formulating judgments, even from incomplete or limited information, including reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments.

- Carry out autonomous learning that allows them to continue studying in a way that will, to a large extent, be self-directed.

- Assess the problems of representativeness, accuracy, precision and uncertainty in the taking of samples and field and laboratory data.

- Have developed sufficient autonomy to participate in research projects and scientific or technological collaborations and, if necessary, lead and / or coordinate work teams within the field of Earth Sciences, in interdisciplinary contexts, where appropriate, with a high component of knowledge transfer.

- Assume responsibility for their own professional development and specialization in one or more fields of study within Geology.

- Recognize and respect the points of view and opinions of other team members and be able to assess their own performance as an individual and as a member of a team.

- Manage, discriminate and select bibliographic information sources.

- Develop the ability to critically analyze, synthesize and summarize previous geoscientific information.

- Gather and integrate various types of evidence to formulate and test hypotheses, applying the scientific method in the framework of geological investigations.

- Obtain, store, analyze and model geological data, as well as select and use the appropriate field, laboratory and cabinet techniques.

- Select and apply the most appropriate methodologies and techniques to plan and carry out both basic and applied geological research work.

2.2. Learning goals

The student, to pass this subject, must demonstrate the following results ...

A) Identify the main properties of interest (physical, mechanical and chemical) in the characterization of materials geological and knows their study methods and applications.

B) It is capable of assessing the operational, sampling, economic and administrative requirements of the different techniques and methods applicable in Geology, for prospecting and fundamental and applied research.

C) Take and properly process geological samples. Knowing how to select the most appropriate laboratory and field techniques and methods to obtain results in accordance with the objectives of a specific geological study.

D) Knows and is able to assess the different dating methods in Geology, being able to select the most appropriate to the problem under study.

2.3. Importance of learning goals

Students, with this subject, acquire the necessary training to be able to successfully tackle the rest of the more specific subjects within the degree. The development of new advanced study techniques in Geology requires that students know the wide range of study techniques and methods that can be applied to solving geological problems at different scales, as well as the type of results expected from each of them. This theoretical and practical knowledge is the basis of any subsequent study and is the most significant formative result of this subject.

3. Assessment (1st and 2nd call)

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

The student must demonstrate that he has achieved the expected learning results through the following evaluation activities.

In the face-to-face development of the subject the evaluation will be carried out through a series of continuous evaluation activities, as detailed below:

1. Written tests (50% of the final grade). There will be several written tests throughout the semester. The tests will have the format of theoretical-practical questionnaires that will be answered, during school hours, at the end of each topic or block of topics. The weight of each individual questionnaire in the final grade will be proportional to the hours of teaching of the topic or block of topics it covers.

2. Completion of work and reports (50% of the final grade, the weight of each practice being proportional to their hours of attendance). Throughout the semester will carry out various practices related to the contents of each theoretical-practical session. As a general rule, these practices will begin in class and each student must finish them and deliver them on specific dates that will be announced at the beginning of each of the modules.

Global evaluation:

Theoretical and practical written exam: For those students who do not pass the subject through continuous evaluation or who choose this mode of evaluation, a theoretical and practical exam will be carried out to evaluate the achievement of the expected learning results. This global exam will have a valuation of 100% of the final grade.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The learning process in this subject is based on:

1.- Master Class (4.9 ECTS)

2.-Practical classes (2.5 ECTS) that include the resolution of problems and cases, laboratory practices and teaching assignments or seminars

3.-Special practices (Field practices; 1.6 ECTS, two one-day trips)

4.2. Learning tasks

The program offered to the student to help him achieve the expected results includes the following activities ...

1. Master class: Detailed presentation of the topics with the help of ICTs and active participation of the students.

2. Problems and cases: Approach and resolution of problems based on real or possible cases, with application of general or specific computer programs.

3. Laboratory practices: Implementation of laboratory work methodologies with the appropriate equipment and techniques for each practice.

4. Teaching work or seminars: Presentation and sharing of work or case studies, prepared by the students and debate on the results obtained.

5. Special practices: Identification of the relevant geological characteristics of the study areas and application of the appropriate study and sampling strategies.

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

Theory program

MODULE 1: Instrumental techniques: requirements and applications

1.1. Determination of physical and mechanical properties 1.1.1. Porosity, permeability, density. Interaction with water and induced physical changes 1.1.2. Surface analysis and color measurement. Study techniques 1.1.3. Indirect measures of physical properties: Ultrasonic pulses, methodology and possibilities 1.1.4. Magnetic properties Fundamentals of rock magnetism Rock magnetism techniques.

1.2. Introduction to mineral and chemical characterization techniques 1.2.1. Mineral-chemical characterization techniques: X-ray, diffraction Electron microscopy (SEM and TEM), Electron microprobe 1.2.2. Chemical characterization techniques. Solid sample techniques: X-ray fluorescence, Neutron activation, Laser ablation. Liquid sample techniques: selective electrodes, Colorimetry, atomic emission/absorption, ICP and ICP-MS 1.2.3. Isotopic techniques. Isotopes in Geology: Importance and Applications. Stable isotopes: O, D / H, C, S, N. Most relevant radiogenic isotopes. Techniques for isotopic microanalysis: laser ablation, ionic probe 1.2.4. Other techniques: ATD / ATG, infrared spectrometry.

MODULE 2: Dating geological materials

2.1. Radioisotope techniques. Radioactive decay: characteristics and law of decay. Reference values ??and model ages. Long-lived isotopic systems (Rb-Sr, Sm-Nd, U-Pb, K-Ar and Ar / Ar): application ranges. Closing and opening of the isotopic systems. Isochrone-based methods and associated errors. Chronic error. Concord methods: U-Pb, Pb-Pb and model age. Applications. K-Ar and 39Ar / 40Ar Methods. Applications of microanalytical techniques: laser ablation and ionic microprobe. Other radioisotope methods (radiocarbon, cosmogenic nuclides, Uranium, Lead and Cesium series) Luminescence (OSL). Chemical methods (racemization of amino acids) and biological methods (lichenometry and dendrochronology).

2.2. Thermochronology Natural and induced fission traces. Theoretical and operational basis of dating by fission traces. Range of application and evolution models Applications.

2.3. Cyclostratigraphy 2.3.1. Periodic sedimentary cycles Periodic sedimentary cycle concept Periodic cyclical sedimentation frequency bands Factors that modulate cycles 2.3.2. Sedimentary cycles controlled by orbital parameters Sedimentary cycles generated by gravitational processes: tidal cycles. Sedimentary cycles generated by climatic processes 2.3.3. Application of periodic sedimentary cycles to the dating and correlation of geological series Timing Correlation and anchorage.

2.4. Geochronological applications of paleomagnetism 2.4.1. Fundamentals of paleomagnetism The Earth's magnetic field

(CMT) Geometry and variations of the CMT: reference systems. Geomagnetic Coordinates CMV Models Internal CMT Variations Secular Variation Polarity Investments 2.4.2. Paleomagnetism techniques Field work Natural Remaining Magnetization (NRM) and its measurement Demagnetization techniques: thermal and by alternate fields Paleomagnetic components and representation systems Treatment of paleomagnetic data 2.4.3. Magnetostratigraphy CMTGPTS inversion sequence Magnetostratigraphy applications 2.4.4. Secular Variation Studies Archeomagnetism.

2.5. Biochronological methods 2.5.1. Fossils as a dating tool 2.5.2. Limitations of the biochronological scales 2.5.3. Construction and calibration of the biochronological scales 2.5.3.1. Qualitative methods High resolution method Integrated biostratigraphy Graphical correlation method 2.5.3.2. Quantitative methods High biostratigraphy Statistical biostratigraphy.

2.6. Chronostratigraphy and GeochronologyGSSPs definition procedures (Global Boundary Stratotype Section & Point) Integration of dating methods and construction of the International Geological Time Scale.

Practice program:

Module 1 (12 h): - Determination of petrophysical properties: density, porosity , permeability (7 hours). - Practical session of rock magnetism techniques (5h).

Module 2 (13 h): - Dating of series with sedimentary cyclicality (4h). - Dating with magnetostratigraphy (5h). - Dating with biocronology (4h).

Two days of field practices (special practices) of cyclo-stratigraphy and color sedimentology (16h)

4.4. Course planning and calendar

- The course will be taught in theoretical-practical sessions of 2.5 hours in duration according to the schedules that are published each year on the website of the Faculty of Sciences.

- The field practice sessions (special practices) will be held on the dates assigned according to the field departure schedule of the degree that is published on the website of the Department of Earth Sciences.

- Start of the course: start of the first semester according to the academic calendar published on the website of the Faculty of Science.

- Exam dates: according to the calendar published on the website of the Faculty of Sciences.

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=60375