Universidad Zaragoza

Year : 2019/20

60438 - Subsurface geology

Syllabus Information

Academic Year: 2019/20
Subject: 60438 - Subsurface geology
Faculty / School: 100 - Facultad de Ciencias
Degree: 541 - Master's in Geology: Techniques and Applications
ECTS: 5.0
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:

- To acquire an accurate picture of the methods of subsurface exploration, and of the applicability of each method, to be able to select the best suited for each case.

- To acquire the skills necessary for managing geophysical prospecting, data processing and interpretation of the results obtained.

- To be able to integrate the results of different methods and construct simple 3D models of the subsoil.

1.2.Context and importance of this course in the degree

It is a subject of great interest for those students interested in specializing in tectonics, basin analysis, prospecting of natural resources, archaeology and hydrogeology, who need to know the geometry of the formations and structures in depth.

1.3.Recommendations to take this course

The level is directed at graduates who typically are majoring in geology. However, this module is also appropriate for students majoring in other disciplines (hydrogeology, civil engineering, archaeology, economic geology) that require some knowledge of geophysical methods and reconstruction of the structure of the subsoil.

2.Learning goals

2.1.Competences

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

To plan a survey by selecting subsurface exploration prospecting techniques best suited for each case.

To operate equipment normally used in geophysical prospecting: gravimetric, magnetic, electromagnetic and GPR.

To work autonomously with maps of gravimetric and magnetic anomalies of specific areas and interpret them in geological terms.

To apply inverse modelling algorithms and to interpret gravimetric and magnetic anomalies of large and small scale.

To interpret seismic refraction profiles and apply them to the interpretation of the subsurface structure.

To interpret seismic reflection profiles in geological terms and to apply them to the knowledge of the geology of a region, in combination with magnetometry and gravimetry.

To interpret well logs and apply them to seismic prospecting.

To interpret electrical and electromagnetic profiles and apply them to the interpretation of the subsurface structure.

To construct simple 3D models of the subsoil.

2.2.Learning goals

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

1. Ability to plan a survey by selecting subsurface exploration prospecting techniques best suited for each case.

2. Operates equipment normally used in shallow subsurface geophysical surveys (gravimeter, magnetometer,

electromagnetic, GPR).

3. Works autonomously with maps of gravimetric and magnetic anomalies of specific areas and interprets it in geological terms.

4. Applies inverse modelling algorithms and is able to interpret gravimetric and magnetic anomalies of small and large scale.

5. Ability to interpret seismic refraction profiles and to apply them to the interpretation of the subsurface structure.

6. Ability to interpret seismic reflection profiles in geological terms and ability to apply them to the knowledge of the geology of a region, in combination with magnetometry and gravimetry.

7. Ability to interpret and apply well logs to seismic prospecting.

8. Ability to interpret electrical and electromagnetic profiles and apply them to the interpretation of the subsoil structure.

9. Ability to construct structural maps and simple 3D models of the subsoil.

2.3.Importance of learning goals

Geophysical prospecting methods are an essential tool for subsurface geology.

3D modelling has become an indispensable tool in the interpretation of the geology of a region in deep.

3.Assessment (1st and 2nd call)

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

Continuous assessment:

1. Resolution of up to 4 questionnaires (40%)

2. Coursework about practice sessions (40%)

3. Report of the results of the survey (20%)

Global assessment:

Written theoretical-practical exam (100%)

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

A wide range of teaching and learning tasks are implmented. The 5 ECTS of this course correspond to 50 hours of onsite activities, which will be arranged in theory sessions, practice sessions, field work session and assignments. Tutorials will be considered another academic activity where the student will be free to ask doubts related to the course.

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. Students are provided with task guidelines for each practice session.

Classroom materials will be available via Moodle.

4.2.Learning tasks

The course includes the following learning tasks:

- 12 hours of lectures (1.5 h/week).
- 20 hours of practice sessions (2.5 h/week).
- 8 hours of seminars and guided work.
- 6 hours of field-survey, plus 4h of field data processing.

4.3.Syllabus

The course will address the following topics:

Lectures

Topic 1. Methods of subsurface exploration: Cross-sections and structure contour maps, mechanical methods, geophysical methods. Physical properties of sediments and rocks. Limitations of geophysical methods. The advantage of multiple methods. Structure contour maps: Rules of contouring. Contouring styles. TIN and Gridding.

Topic 2. Gravity surveying: Fundamental relationships. Measuring gravity. Correcting observed gravity. Basic field procedures. Analyzing anomalies (regional and residual). Gravity interpretation. Applications of the gravity method.

Topic 3. Magnetic surveying: Fundamental relationships. The Earth's magnetic field. Measuring the magnetic field. Basic field procedures. Interpretation of magnetic data. Applications of the magnetic method.

Topic 4. Seismic exploration: Seismic waves and wave propagation. Ray paths in layered materials. Wave attenuation and amplitude. Energy sources. Seismic equipment. Seismic refraction surveying: A homogeneous subsurface. A single subsurface interface. Two horizontal interfaces. Multiple interfaces. Dipping interfaces. Multiple dipping interfaces. The non-ideal subsurface. The delay-time method. Other methods. Field procedures.

Topic 5. Seismic reflection surveying: A single subsurface interface. Multiple horizontal interfaces. Dipping interface. Acquiring and recognizing reflections from shallow interfaces. Common field procedures. Computer processing of reflection data (static correction, normal move-out, stacking CDP gathers, migration).

Topic 6. Borehole logging: Drilling and its effects on the formations. The measurement of strata dip, borehole inclination and diameter. The self-potential log. Resistivity logs. Radioactivity logs. The sonic log. The temperature log. Logging outside the oil industry.

Topic 7. Electrical surveys: Resistivity methods: Vertical electric sounding (VES). Resistivity profiling. Electrical imaging. Induced polarisation (IP) and self-potential (SP). Electromagnetic methods: Electromagnetic systems: Slingram, Turam. Transient electromagnetic (TEM) systems. Magnetoteluric (MT) surveying. Ground Penetrating Radar (GPR).

Topic 8. Methodology and software of 3D reconstruction and restitution.

Practice sessions

Section 1. Problem sheets:

1. Construction of cross-sections and subsurface structure contour maps from borehole.

2. Correcting observed gravity and analysing regional and residual anomalies.

3. 2.5D gravity and magnetic inverse modelling using GravMag 32.

4. Seismic refraction interpretation and modelling using REFRACT.

5. Interpretation of seismic reflection profiles.

6. Interpretation of well logs and its application in seismic reflection profiles.

7. Integrated example: interpretation of the subsurface geology of an area from gravity, magnetic, refraction, reflection and log data.

10. 3D modelling with real data using Move.

Section 2. Survey:

8. Field survey using gravity, magnetic, electromagnetic (Slingram and GPR), electrical and seismic refraction methods.

9. Transfer and processing of data from field survey.

4.4.Course planning and calendar

The learning activities are organized into combined theory and practice sessions. A typical session consists of two parts, the first one is theoretical (1:30 h), and the second one is a practice session (2:30 h).

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.

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.

4.5.Bibliography and recommended resources

http://biblos.unizar.es/br/br_citas.php?codigo=60438&year=2019