60438 - Subsurface geology

Información del Plan Docente

Academic Year	2016/17
Academic center	100 - Facultad de Ciencias
Degree	541 - Master's in Geology: Techniques and Applications
ECTS	5.0
Course	1
Period	Second semester
Subject Type	Optional
Module	---

1.Basic info

1.1.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.

1.2.Activities and key dates for the course

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.Initiation

2.1.Learning outcomes that define the subject

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.

6. 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.

2.2.Introduction

The aim of this module is to provide the fundamental principles of common methods of subsurface exploration, with special emphasis on the application of geophysical prospecting methods to interpretation of subsurface structure at depth.

3.Context and competences

3.1.Goals

- 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.

3.2.Context and meaning of the subject 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.

3.3.Competences

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.

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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.

3.4.Importance of learning outcomes

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.

4.Evaluation

Continuous assessment:

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

2. Laboratory sessions (40%)

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

Overall assessment:

Written theoretical-practical exam (100%)

5.Activities and resources

5.1.General methodological presentation

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 20 hours of theoretical courses, 24 hours of laboratory sessions and 6 hours of field-work.

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

5.2.Learning activities

- 12 hours of theoretical classes (1,5 h/week).

- 8 hours of seminars and guided works.

- 24 hours of lab sessions (3 h/week).

- 6 hours of field-survey.

5.3.Program

Contents/Lectures

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.

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

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.

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.

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).

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.

7. Electrical surveys: Resistivity methods: Vertical electric sounding (VES). Resistivity profiling. Electrical imaging. Induced polarisation (IP) and self-potential (SP).

8. Electromagnetic methods: Electromagnetic systems: Slingram, Turam. Transient electromagnetic (TEM) systems. Magnetoteluric (MT) surveying. Ground Penetrating Radar (GPR).

9. Methodology and software of 3D reconstruction and restitution.

Practical/Problems:

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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.

Practical/Survey:

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

9. Transfer and processing of data from field survey.

5.4.Planning and scheduling

Learning activities are organized into combined theoretical and practical sessions. A typical session consists of two parts, the first of theoretical class (1:30 h), and the second of lab session (3 h).

5.5.Bibliography and recomended resources

* Burger, Henry Robert. Exploration geophysics of the shallow subsurface / H. Robert Burger ; accompanying Macintosh Computer Service by Douglas C. Burger and H. Robert Burger Englewood Cliffs : Prentice Hall, 1992
* Burger, Henry Robert. Introduction to applied geophysics : exploring the shallow subsurface / H. Robert Burger , Anne F. Sheehan , Craig H. Jones. New York : W.W. Norton , 2006
* Dobrin, Milton B.. Introduction to geophysical prospecting / Milton B. Dobrin, Carl H. Savit . - 4th ed. New York [etc.] : McGraw-Hill, cop. 1988
* Kearey, Philip. An introduction to geophysical exploration / Philip Kearey, Michael Brooks, Ian Hill . - 3rd ed. Oxford : Blackwell Science, 2002
* Milsom, John.. Field geophysics / John Milsom. . - 3rd ed. Chichester [etc.] : John Wiley & Sons, 2003
* Mussett, Alan E.. Looking into the Earth : an introduction to geological geophysics / Alan E. Mussett, M. Aftab Khan ; illustrations by Sue Button. . - [1st publ.] Cambridge : Cambridge University Press, 2000
* Parasnis, D.S.. Principles of applied geophysics / D.S. Parasnis . - 5th ed. London [etc.] : Chapman and Hall, 1997
* Reynolds, John M.. An introduction to applied and environmental geophysics / John M. Reynolds

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Chichester [etc] : John Wiley & Sons, 1997
* Robinson, Edwin S.. Basic exploration geophysics / Edwin S. Robinson, Cahit à?oruh. New York : Wiley, cop. 1988
* SHERIFF, R. Geophysical methods. Prentice Hall/Pearson Education. 1989
* Sleep, Norman H.. Principles of geophysics / Norman H. Sleep, Kazuya Fujita. Malden, Massachusetts [etc.] : Blackwell Science, cop. 1997
* Telford, W. M.|q(William Murray). Applied geophysics / W. M. Telford, L. P. Geldart, R. E. Sheriff . - 2n ed.,[transferred printing] Cambridge : University Press, 2004

Complementary resources:

* HATTON, L.. Seismic data processing. Blackwell Scientific. 1986.
* Jones, E. J. W.. Marine geophysics / E.J.W. Jones. Chichester [etc.] : John Wiley & Sons, cop. 1999.
* Waters, Kenneth H.. Reflection seismology : A Tool for Energy Resource Exploration / Kenneth H. Waters . - 3rd. ed. Florida : Krieger Publishing Company, 1992
* MCDOWELL, P.W.. Geophysics in engineering investigations. Construction Industry Research & Information Association. 2002
* OSWIN, J. . A field guide to geophysics in archaeology. Springer. 2009
* Sharma, Prem Vallabh. Environmental and engineering geophysics / Prem V. Sharma Cambridge : Cambridge University Press, 1997
* Shearer, Peter M.. Introduction to seismology / Peter M. Shearer . - 2nd ed. Cambridge : Cambridge University Press, 2009
* SHERIFF, R.E.. Exploration seismology, vol. 1: History, theory and data acquisition. Cambridge University Press. 1983
* SHERIFF, R.E.. Exploration seismology, vol. 2: Data processing and interpretation. Cambridge University Press. 1983

Websites:

1. Geophysical data center (USA):http://www.ngdc.noaa.gov/
2. Instituto Geológico y Minero de España: http://www.igme.es
3. Instituto geográfico nacional (ESP): http://www.ign.es/ign/es/IGN/home.jsp
4. Geomagnetismo: http://geomag.usgs.gov/