Course Guide

GEOLOGY

FACULTAD DE CIENCIAS QUÍMICAS
UNIVERSIDAD COMPLUTENSE DE MADRID
ACADEMIC YEAR 2022-2023

I.- SPECIFICATIONS

COURSE NAME:	**Geology**
CHARACTER:	**Compulsory**
SUBJECT:	**Geology**
MODULE:	**Basic**
DEGREE:	**Bachelor in chemistry**
SEMESTER:	**Second semester (first year)**
DEPARTMENT:	**Mineralogy and Petrology (Crystallography and Mineralogy) (Facultad de Ciencias Geológicas)**

RESPONSIBLE LECTURERS:

Coordinator	**Lecturer:**	SOL LÓPEZ ANDRÉS
	Department:	Mineralogy and Petrology
	Office:	7D, 6th floor
	e-mail:	antares@ucm.es

Group A (Spanish)		
Theory Seminars Tutorials	**Lecturer:**	ASSISTANT Ph.D.
	Department:	Mineralogy and Petrology
	Office:	XX, 6th floor
	e-mail:	XXXX@ucm.es
Exercises	**A1:** Assistant Ph.D. and Nuria Sánchez Pastor **A2:** Assistant Ph.D. and Javier García Rivas	
Group B (Spanish)		
Theory Seminars Tutorials	**Lecturer:**	SOL LÓPEZ ANDRÉS
	Department:	Mineralogy and Petrology
	Office:	7D, 6th floor
	e-mail:	antares@ucm.es
Exercises	**B1:** Sol López Andrés and Nuria Sánchez Pastor **B2**: Sol López Andrés and Assistant Ph.D.	
Group C (Spanish)		
Theory Seminars Tutorials	**Lecturer:**	JAVIER GARCÍA RIVAS
	Department:	Mineralogy and Petrology
	Office:	15, 6th floor
	e-mail:	javier.garcia.rivas@ucm.es
Exercises	**C1**: Javier Garcia Rivas and Assistant Ph.D. **C2**: Javier Garcia Rivas and Carlos Pérez Garrido	

Group D (Spanish)	
Theory Seminars Tutorials	**Lecturer:** CARLOS PÉREZ GARRIDO **Department:** Mineralogy and Petrology **Office:** 10C, 6th floor **e-mail:** carlospgarrido@geo.ucm.es
Exercises	**D1:** Carlos Pérez Garrido y Nuria Sánchez Pastor **D2**: Carlos Pérez Garrido y Nuria Sánchez Pastor
Group E (English)	
Theory Seminars Tutorials	**Lecturer:** NURIA SÁNCHEZ PASTOR **Department:** Mineralogy and Petrology **Office:** 12B, 6th floor **e-mail:** nsanchez@ucm.es
Exercises	**E1:** Nuria Sánchez Pastor and Javier García Rivas **E2:** Nuria Sánchez Pastor and Javier García Rivas
Group F (Spanish)	
Theory Seminars Tutorials	**Lecturer:** VICTORIA LÓPEZ-ACEVEDO CORNEJO **Department:** Mineralogy and Petrology **Office:** 7B, 6th floor **e-mail:** vcornejo@ucm.es
Exercises	**F1:** María Victoria López-Acevedo Cornejo and Assistant Ph.D. **F2:** María Victoria López-Acevedo Cornejo and Nuria Sánchez Pastor

II.- OBJECTIVES

■ GENERAL OBJECTIVES

- The main objective of this course is to provide students with enough geological skills to continue their studies in Chemistry and multidisciplinary areas.
- To instill in students the need to commit to self-learning.

■ SPECIFIC OBJECTIVES

- To develop the capacity for structure analysis and study of the composition and properties of crystalline materials (minerals and rocks).
- Describe and assess the qualitative changes that may take place in crystalline materials (minerals and rocks) in a natural or induced way.
- To learn the suitable characterization techniques in Geology to determine the qualitative or quantitative composition of the geological materials

III.- PREVIOUS KNOWLEDGE AND RECOMMENDATIONS

PREVIOUS KNOWLEDGE:

Basic concepts of chemistry, mathematics and physics.

RECOMMENDATION:

Understand scientific texts.

IV.- CONTENTS

BRIEF DESCRIPTION:

Introduction to Geology. Origin of Earth and Earth structure. Crystallography. Crystal structures. Crystal morphology. Mineralogy. Crystal chemical classification of minerals. Petrology. Classification of rocks. Geological resources.

SYLLABUS:

PART I: **Introduction**

Unit 1: The relationship between Chemistry and Geology

PART II: **Crystallography**

Unit 2: Periodicity

- Translation. Lattice. Motif.
- Unit cell and primitive unit cell. Unit cell parameters or metric restrictions.
- Reticular line. Reticular plane.
- Two-dimensional lattices. Three-dimensional lattices. Two-dimensional crystal systems. Bravais lattices.

Unit 3: Symmetry

- Symmetry elements.
- Two-dimensional point groups. Glide operation. Two-dimensional space groups.
- Three-dimensional point groups. Symmetry center. Proper and improper axes. 32 Point Groups. The 7 crystal systems. Deduction of Bravais's lattices. Symmetry of Bravais's lattices. Screw axes.

Unit 4: Crystal morphology

- Miller indices. The hexagonal lattice. Zone and zone axis.
- Morphological symmetry.
- Stereographic projection.

Unit 5: Crystal structures and symmetry

- 230 space groups.
- International Tables for X-ray Crystallography.

Unit 6: Crystal chemistry

- Pauling's rules. Coordination number and coordination polyhedra. Close-packed structures. Derivate structures. Model structures.
- Structure´s projection
- Mineral classification.

Unit 7: Defects in minerals and crystal growth

- Point defects, line defects, planar defects and threw dimensional defects.
- Polymorphism, isomorphism and solid solutions.
- Introduction to crystal growth.

PART III: **Mineralogy**

Unit 8: Earth's origin and structure

Unit 9: Silicates

- Silicate structure and classification.
- Nesosilicates: olivine group, garnet group
- Cyclosilicates: tourmaline, beryl
- Inosilicates: pyroxenes and amphiboles
- Phyllosilicates: micas and clay minerals
- Tectosilicates: silica group, feldspars, zeolites.

Unit 10: Non-silicate minerals

- Native elements: sulphur, graphite, diamond
- Sulphurs: galena and pyrite
- Halides: halite, fluorite
- Oxides : hematite, corundum, magnetite, perovskite
- Carbonates: calcite, aragonite
- Sulphates: gypsum, anhydrite

PART IV: **Geological resources**

Unit 11: Mineral resources

- Ore deposits and industrial minerals.
- Applied mineralogy.

Unit 12: Exploitation of geological resources: needs and consequences

- Abundant and scarce metals.
- Mineral resources and the environment.

V.- COMPETENCES

GENERAL:

- **CG2:** To recognize the importance of chemistry to other areas, and its relation to other disciplines.
- **CG3:** To be able to progress to more specialized areas of chemistry, or multidisciplinary areas.

- **CG7:** To recognize new problems and plan methods to solve them.

- **SPECIFIC:**
  - **CE35:** To describe mineral genesis and transformation processes.
  - **CE36:** To describe the most common crystal structures.
  - **CE37:** To identify rocks and minerals using suitable classification terms.

- **TRANSVERAL:**
  - **CT1:** To write technical and scientific reports.
  - **CT2:** To work as a team.
  - **CT3:** To demonstrate critical thinking and self-criticism.
  - **CT4:** To be able to adapt to new situations.
  - **CT11:** To work autonomously.

VI. – LEARNING OUTCOMES

Having passed this course, the student should be able:

Crystallography

- To know the basic concepts of periodicity, lattice, motif and cell.
- To index the planes and directions in crystals and the hexagonal lattice.
- To identify the two-dimensional symmetry elements.
- To identify the two-dimensional point groups.
- To identify the two-dimensional space groups.
- To identify the three-dimensional symmetry elements.
- To identify the 32 three-dimensional point groups.
- To understand the fundamentals of stereographic projection.
- To identify crystal forms.
- To understand and interpret the information provided by the 230 space groups.
- To use of the International Tables for X-ray Crystallography as a fundamental tool in crystallography.
- To identify close-packed and coordination structures.
- To project mineral structures.
- To calculate the density of crystals.
- To identify crystal defects.
- To identify solid solutions.

Mineralogy

- To classify minerals.
- To identify the geological environments where minerals form.
- To know the structure, composition, processes and distribution in nature of the most common silicates.
- To identify the structure, composition, processes and distribution in nature of the most frequent non-silicates.
- To identify minerals by their physical properties.

Geological Resources

- To know mineral, water and energy resources.
- To relate geological resources and environment.

To carry out a group work related to Crystallography, Mineralogy or Geological Resources

VII. – ACTIVITY WORKLOAD DISTRIBUTION

Activity	On-course (hours)	Individual work (hours)	Credits
Lectures	35	52	3,3
Problem classes	12	18	1,2
Seminars	3	7.5	0.3
On-course assignment	3	4,5	0,3
Written assignments and exam preparation	7	18	0,9
Total	**60**	**90**	**6,0**

VIII.- METHODOLOGY

On-course activities include theoretical lessons, seminars, exercise and problem-solving classes, and tutorials. Students will be provided with the appropriate teaching material through the Virtual Campus. The professor will present concisely the theoretical concepts that allow the student to approach the study and understanding of the subject (2 h /week). Computer-aided classroom presentations will be used as support.

Practical lessons will consist of problem-solving sessions to apply the acquired knowledge (1.30 h/week for 10 weeks). Prior to the class, students will have a list of the exercises to carry out. Along the course, additional take-home exercises may be assigned. In addition, exercises or test like those discussed in problem-solving sessions may be given during lecture hours and graded.

Non-attendance activities may include **evaluable exercises**, **group work, visit to museums, research assistance centres, exhibitions and fairs.**

The group work will be focused on the resolution of practical cases related to geology and chemistry. This will allow the student to develop transversal skills and abilities such as: information search, synthesis capacity and group work.

The instructor will answer both the theoretical and problem-related questions from the students in the office during tutoring hours.

IX.- BIBLIOGRAPHY

- **BASIC:**
  - KLEIN, C.; HURLBUT, C. S.; DANA, J.D.: "*Manual of mineralogy,* after J.D. Dana", 21st ed. 1999.
  - REDUCA: "*Serie Fundamentos de Geología*", Vol. 2, Núm. 4 (2010). http://www.revistareduca.es/index.php/reduca-geologia
- **COMPLEMENTARY:**
  - DYAR, M. D.; GUNTER, M. E.; TASA, D.: "*Mineralogy and optical mineralogy"* Ed. Mineralogical Society of America. 2008.
  - CRAIG, J. R.; VAUGHAN, D. J.; SKINNER, B. J.: "*Resources of the Earth: Origin, Use, and Environmental Impact",* 3rd ed., Pearson, 2001.
  - CARRETERO, M. I.; POZO, M.: *"Mineralogía aplicada. Salud y Medio Ambiente"*. 1ª ed., Thomson, 2007.
  - LÓPEZ-ACEVEDO, V.: "*Modelos en cristalografía*", 1993.
  - NESSE, W. D.: *"Introduction to Mineralogy"*, Oxford University Press, 2009.
  - TARBUCK E. J.; LUTGENS, F. K.: *"Earth Science"*, 10th ed. Pearson, 2003.
  - WENK, H. R.; BURLAKH, A.: "*Minerals: their constitution and origin",* Cambridge University Press, 2004.

X.- LEARNING ASSESMENT

In order to be able to carry out continuous evaluation, i.e. to pass the subject through partial examinations, homework, projects, class participation, students must have at least 80% attendance at the on-course activities and carry out the proposed take-home activities.

The student's academic performance and the final grade will be computed considering the percentages shown below.

The evaluation of the ongoing activities during the course will be communicated to the students in advance of the final exam. In particular, the grades of the mid-term's examinations will be communicated within a maximum period of 20 days.

In any case, the minimum period of 7 days between the publication of the grades and the date of the final exam will be respected.

- **WRITTEN EXAMS: 70%**

  The general skills CG2, CG3 y CG7 and the specific skills CE35, CE36 y CE37 will be evaluated. There will be two partial tests, the first at the end of Unit 5 and the second at the end of block V. Moreover, there will be a final course examination for students with a lower grade tan 5 in the partial test or students who want to improve the grade.

- **ON-COURSE ASSIGNEMENT: 15%**

- GROUP WORK: The transversal skills CT1, CT2, CT3, CT4 y CT11 will be evaluated (10%)
- ON-COURSE PRACTICAL ACTIVITIES: Mineral identification. The specific skill CE37 will be evaluated (5%)

■ **ASSESSED EXERCISES:** **15%**

The specific skill CE36 will be evaluated.

ACTIVITY SCHEDULE

UNIT	ACTIVITY	HOURS	GROUPS	START	END
1. Relationship between Chemistry and Geology	Lectures	1	1	Week 1	Week 1
2. Periodicity	Lectures	1,5	1	Week 1	Week 1
3. Symmetry	Lectures	7,5	1	Week 2	Week 4
Periodicity	Problem classes	1,5	2	Week 3	Week 3
4. Crystal morphology	Lectures	2,5	1	Week 4	Week 4
Symmetry I, II, III and IV	Problem classes	6	2	Week 4	Week 7
5. Crystal structures and symmetry	Lectures	5	1	Week 5	Week 6
6. Crystal chemistry	Lectures	3,5	1	Week 7	Week 8
7. Defects in minerals and crystal growth	Lectures	4	1	Week 9	Week 10
Crystal growth/Close packed structures	Problem classes	1,5	2	Week 10	Week 10
8. Earth's origin and structure	Lectures	2,5	1	Week 11	Week 11
Structures	Problem classes	3	2	Week 11	Week 11
9. Silicates	Lectures	2,5	1	Week 12	Week 12
10. Non-silicate materials	Lectures	2,5	1	Week 13	Week 13
Group work	Problem classes	1,5	2	Week 13	Week 13
11. Mineral resources **12. Exploitation of geological resources: needs and consequences**	Lectures	2,5	2	Week 14	Week 14
Mineral identification	Problem classes	1,5	2	Week 14	Week 14

SUMMARY OF ACTIVITIES

Teaching activity	Associated competences	Lecturer activity	Student activity	Learning assessment	P	NP	Total	G
Theory	CG2; CG3; CG7 CE35; CE36; CE37 CT3; CT4	• Theoretical concepts.	• Attendance and note-taking. Questions and doubts.	• Evaluation of the written answers (approach and result) for the resolution of practical exercises.	35	47,5	82,5	
Practical	CG2; CG3; CG7 CE35; CE36; CE37 CT3; CT4	• Application of theoretical concepts to problem solving.	• Problem solving.	• Evaluation of the experimental work.	15	22,5	37,5	
On-course assignment: **1. Group work** **2. Mineral identification**	CG2; CE35; CE36; CE37 CT1; CT2; CT3; CT4; CT11	• Preparation and lecturing of mineral identification. • Proposal and organization of group works.	• Preparation of the report for the group work. • Identification of minerals and rocks.	• Mineral identification exam. • Review and evaluation of the report.	3	4,5	4,5	15%
Seminars	CG2; CE35; CE36, CE37; CT1; CT2; CT3; CT4; CT11	• Proposal and organization of activities, test and problems.	• Problem solving.	• Review and evaluation of the work.	0	4,5	7,5	15%
Exams	CG2 CE35; CE36; CE37 CT3; CT4	• Proposal, monitoring and correction of exams. Student grading.	• Exam elaboration and setup.	• Correction and evaluation of the exams.	7	15,5	22,5	70%
P: on-course activity; NP: off-class activity; G: grade								