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:

<table>
<thead>
<tr>
<th>Coordinator</th>
<th>Lecturer:</th>
<th>Department:</th>
<th>Office:</th>
<th>e-mail:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SOL LÓPEZ ANDRÉS</td>
<td>Mineralogy and Petrology</td>
<td>7D, 6th floor</td>
<td><a href="mailto:antares@ucm.es">antares@ucm.es</a></td>
</tr>
</tbody>
</table>

Group A (Spanish)

<table>
<thead>
<tr>
<th>Theory Seminars Tutorials</th>
<th>Lecturer: VICTORIA LÓPEZ-ACEVEDO CORNEJO</th>
<th>Department: Mineralogy and Petrology</th>
<th>Office: 7B, 6th floor</th>
<th>e-mail: <a href="mailto:vcornejo@ucm.es">vcornejo@ucm.es</a></th>
</tr>
</thead>
</table>
| Exercises                 | A1: Victoria López-Acevedo Cornejo and Juan Luis Martín Vivaldi  
A2: Victoria López-Acevedo Cornejo and Juan Luis Martín Vivaldi |

Group B (Spanish)

<table>
<thead>
<tr>
<th>Theory Seminars Tutorials</th>
<th>Lecturer: SOL LÓPEZ ANDRÉS</th>
<th>Department: Mineralogy and Petrology</th>
<th>Office: 7D, 6th floor</th>
<th>e-mail: <a href="mailto:antares@ucm.es">antares@ucm.es</a></th>
</tr>
</thead>
</table>
| Exercises                 | B1: Sol López de Andrés and Elena Vindel Catena  
B2: Sol López de Andrés and Elena Vindel Catena |

Group C (Spanish)

<table>
<thead>
<tr>
<th>Theory Seminars Tutorials</th>
<th>Lecturer: ELENA VINDEL CATENA</th>
<th>Department: Mineralogy and Petrology</th>
<th>Office: 16, 6th floor</th>
<th>e-mail: <a href="mailto:evindel@ucm.es">evindel@ucm.es</a></th>
</tr>
</thead>
</table>
| Exercises                 | C1: Elena Vindel Catena and Assistant Professor  
C2: Elena Vindel Catena and Assistant Professor |
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
Course Guide: Geology

III.- PREVIOUS KNOWLEDGE AND RECOMMENDATIONS

- PREVIOUS KNOWLEDGE:
  Basic concepts of chemistry, mathematics and physics.

- RECOMMENDATION:
  Understand scientific texts.

IV.- CONTENTS

- BRIEF DESCRIPTION:

- SYLLABUS:

  **PART I: Introduction**
  **Unit 1:** The relationship between Chemistry and Geology

  **PART II: Crystallography**
  **Unit 2:** Periodicity
  - 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. The 7 crystal systems. Screw axes. Three dimensional space groups.
  **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.
  - Close-packed structures.
  - Mineral crystal-chemical classification.
Unit 7: Defects in minerals and crystal growth
- Point defects, line defects, planar defects and threw dimensional defects.
- Polymorphism, isomorphism and solid solutions.
- Crystal growth.

PART III: Mineralogy

Unit 8: Earth’s origin and structure

Unit 9: Silica materials
- Silicate structure and classification.
- Silica group.
- Feldspar group.
- Feldspar group, olivine, sheet silicates.
- Clay minerals.

Unit 10: Non-silicate materials
- Carbonates (calcite, aragonite).
- Sulphates (Gypsum).
- Halides (halite).

PART IV: Geological resources

Unit 11: Mineral resources
- Ore deposits.
- Applied mineralogy. Perovskite and magnetite. Rare earth minerals.

Unit 12: Exploitation of geological resources: needs and consequences
- Abundant and scarce metals.
- Mineral resources and the environment.

V.- COMPETENCES

■ GENERAL:
  o CG2: To recognize the importance of chemistry to other areas, and its relation to other disciplines.
  o CG3: To be able to progress to more specialised areas of chemistry, or multidisciplinary areas.
  o CG7: To recognize and analyze new problems and plan methods to solve them.

■ SPECIFIC:
  o CE35: To describe mineral genesis and transformation processes.
  o CE36: To describe the most common crystal structures.
  o CE37: To identify rocks and minerals using suitable classification terms.
Course Guide: Geology

- GENERIC:
  - 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.
VI. – WORKING HOURS DISTRIBUTED BY ACTIVITY

<table>
<thead>
<tr>
<th>Activity</th>
<th>Attendance (hours)</th>
<th>Self-study (hours)</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>32</td>
<td>43</td>
<td>3,0</td>
</tr>
<tr>
<td>Problem classes</td>
<td>15</td>
<td>22,5</td>
<td>1,5</td>
</tr>
<tr>
<td>Seminars</td>
<td>3</td>
<td>4,5</td>
<td>0,3</td>
</tr>
<tr>
<td>Tutorials / Guided work</td>
<td>3</td>
<td>4,5</td>
<td>0,3</td>
</tr>
<tr>
<td>Written assignments and exam preparation</td>
<td>7</td>
<td>15,5</td>
<td>0,9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
<td><strong>90</strong></td>
<td><strong>6,0</strong></td>
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</tbody>
</table>

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 in a clear and concise way 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 during 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 similar to those discussed in problem-solving sessions may be given during lecture hours and graded.

Non-attendance activities may include: **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:**
X. - ASSESSMENT PROCEDURE

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 taking into account 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-terms 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: 75%

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 than 5 in the partial test or students who want to improve the grade.

■ ON-COURSE ASSIGNEMENT: 10%

The transversal skills CT1, CT2, CT3, CT4 y CT11 will be evaluated.

■ ON-COURSE PRACTICAL ACTIVITIES: 5%

The specific skill CE37 will be evaluated.

■ ASSESSED EXERCISES: 10%

The specific skill CE36 will be evaluated.
## Activity Schedule

<table>
<thead>
<tr>
<th>UNIT</th>
<th>ACTIVITY</th>
<th>HOURS</th>
<th>GROUPS</th>
<th>START</th>
<th>END</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Relationship between Chemistry and Geology</td>
<td>Lectures</td>
<td>1</td>
<td>1</td>
<td>Week 1</td>
<td>Week 1</td>
</tr>
<tr>
<td>2. Periodicity</td>
<td>Lectures</td>
<td>1.5</td>
<td>1</td>
<td>Week 1</td>
<td>Week 1</td>
</tr>
<tr>
<td>3. Symmetry</td>
<td>Lectures</td>
<td>7.5</td>
<td>1</td>
<td>Week 2</td>
<td>Week 4</td>
</tr>
<tr>
<td>Crystal growth</td>
<td>Problem classes</td>
<td>1.5</td>
<td>2</td>
<td>Week 3</td>
<td>Week 3</td>
</tr>
<tr>
<td>4. Crystal morphology</td>
<td>Lectures</td>
<td>2.5</td>
<td>1</td>
<td>Week 4</td>
<td>Week 4</td>
</tr>
<tr>
<td>Periodicity and symmetry I, II, III y IV</td>
<td>Problem classes</td>
<td>6</td>
<td>2</td>
<td>Week 4</td>
<td>Week 7</td>
</tr>
<tr>
<td>5. Crystal structures and symmetry</td>
<td>Lectures</td>
<td>5</td>
<td>1</td>
<td>Week 5</td>
<td>Week 6</td>
</tr>
<tr>
<td>6. Crystal chemistry</td>
<td>Lectures</td>
<td>3.5</td>
<td>1</td>
<td>Week 7</td>
<td>Week 8</td>
</tr>
<tr>
<td>7. Defects in minerals and crystal growth</td>
<td>Lectures</td>
<td>4</td>
<td>1</td>
<td>Week 9</td>
<td>Week 10</td>
</tr>
<tr>
<td>Structures</td>
<td>Problem classes</td>
<td>4.5</td>
<td>2</td>
<td>Week 8</td>
<td>Week 10</td>
</tr>
<tr>
<td>8. Earth’s origin and structure</td>
<td>Lectures</td>
<td>2.5</td>
<td>1</td>
<td>Week 11</td>
<td>Week 11</td>
</tr>
<tr>
<td>Minerals and rocks identification</td>
<td>Problem classes</td>
<td>1.5</td>
<td>2</td>
<td>Week 11</td>
<td>Week 11</td>
</tr>
<tr>
<td>9. Silica materials</td>
<td>Lectures</td>
<td>2.5</td>
<td>1</td>
<td>Week 12</td>
<td>Week 12</td>
</tr>
<tr>
<td>10. Non-silicate materials</td>
<td>Lectures</td>
<td>2.5</td>
<td>1</td>
<td>Week 13</td>
<td>Week 13</td>
</tr>
<tr>
<td>Group work presentation</td>
<td>Problem classes</td>
<td>1.5</td>
<td>2</td>
<td>Week 12</td>
<td>Week 12</td>
</tr>
<tr>
<td>11. Mineral resources</td>
<td>Lectures</td>
<td>2.5</td>
<td>1</td>
<td>Week 14</td>
<td>Week 14</td>
</tr>
<tr>
<td>12. Exploitation of geological resources: needs and consequences</td>
<td>Lectures</td>
<td>2.5</td>
<td>1</td>
<td>Week 14</td>
<td>Week 14</td>
</tr>
</tbody>
</table>
### SUMMARY OF ACTIVITIES

<table>
<thead>
<tr>
<th>Teaching activity</th>
<th>Associated competences</th>
<th>Lecturer activity</th>
<th>Student activity</th>
<th>Learning assessment</th>
<th>P</th>
<th>NP</th>
<th>Total</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Theory</strong></td>
<td>CG2; CG3; CG7; CE35; CE36; CE37; CT3; CT4</td>
<td>• Theoretical concepts.</td>
<td>• Attendance and note-taking. Questions and doubts.</td>
<td>• Evaluation of the written answers (approach and result) for the resolution of practical exercises.</td>
<td>32</td>
<td>43</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td><strong>Practical</strong></td>
<td>CG2; CG3; CG7; CE35; CE36; CE37; CT3; CT4</td>
<td>• Application of theoretical concepts to problem solving. • Preparation and lecturing of mineral identification.</td>
<td>• Problem solving. • Identification of minerals and rocks.</td>
<td>• Evaluation of the experimental work. • Mineral identification exam.</td>
<td>15</td>
<td>22,5</td>
<td>37,5</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Problem solving classes</strong></td>
<td>CE35; CE36; CE37; CT1; CT2; CT3; CT4; CT11</td>
<td>• Support the students in the resolution of problems.</td>
<td>• Problem solving.</td>
<td>• Supply of proposed problems and exercises.</td>
<td>3</td>
<td>4,5</td>
<td>7,5</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Tutorials</strong></td>
<td>CE35; CE37; CT1; CT2; CT3; CT4; CT11</td>
<td>• Proposal and organization of group works.</td>
<td>• Preparation of the group work.</td>
<td>• Review and evaluation of the work.</td>
<td>3</td>
<td>4,5</td>
<td>7,5</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Exams</strong></td>
<td>CG2; CE35; CE36; CE37; CT3; CT4</td>
<td>• Proposal, monitoring and correction of exams. Student grading.</td>
<td>• Exam elaboration and setup.</td>
<td>• Correction and evaluation of the exams.</td>
<td>7</td>
<td>15,5</td>
<td>22,5</td>
<td>75%</td>
</tr>
</tbody>
</table>

P: on-course activity; NP: off-class activity; G: grade