

**Industrial and Heritage Rocks**

Code: 101050  
ECTS Credits: 4

Degree	Type	Year	Semester
2500254 Geology	OT	3	2
2500254 Geology	OT	4	2

**Contact**

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**Use of Languages**

Principal working language: catalan (cat)  
Some groups entirely in English: No  
Some groups entirely in Catalan: Yes  
Some groups entirely in Spanish: No

**Other comments on languages**

Some of the recommended bibliography is in English

**Teachers**

Joan Reche Estrada  
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**Prerequisites**

A good knowledge of Mineralogy and Petrology (sedimentary, igneous and metamorphic) is strongly recommended.

**Objectives and Contextualisation**

It is an Optional Subject of 4 ECTS credits, framed within the subject matter "Economic Geology", to be chosen by students of third or fourth course level who choose a general education mention path or for students who want to obtain the Geotechnical and Geological Resources Mention .

It deals with various applied aspects of geological materials such as:

- The Industrial Rocks, such as: Dimension stone, aggregates, clays or binder materials (cement, lime or plaster)
- The Industrial Minerals, such as: Borates, Barite, Fluorite, Micas, Talc or Zeolites
- The Heritage rocks: Rocks of the sculptural and architectural heritage and their identification techniques

Each material studies the geological context, mineralogical aspects, methods of exploration and evaluation of deposits, methods of extraction and processing, main uses, control of the quality of products that are derived from them, some socioeconomic aspects and the environmental and sustainability issues that affect them.

## Competences

- Geology
- Evaluate and carry out the selection and collection of suitable geological samples.
- Identify and characterise minerals and rocks through instrumental techniques, determine their formation environments and know their industrial applications.
- Identify and tackle environmental problems, plan land-use and know the principles of prevention and mitigation of geological risks.
- Learn and apply the knowledge acquired, and use it to solve problems.
- Plan the exploration and sustainable development of geological resources.
- Process, interpret and present laboratory data using qualitative and quantitative techniques, and suitable computer programmes.
- Recognise theories, paradigms, concepts and principles in the field of geology and use them in different areas of application, whether scientific or technical.
- Suitably transmit information, verbally, graphically and in writing, using modern information and communication technologies.
- Work independently.

## Learning Outcomes

1. Draw up subsoil interpretation tables and graphs in relation to geological engineering.
2. Evaluate the environmental problems related to mining, industrial rock and hydrocarbon exploitations.
3. Identify metal ores using a reflected light microscope.
4. Identify the environmental problems related to exploitations of hydrocarbons, mineral deposits and industrial rocks.
5. Learn and apply the knowledge acquired, and use it to solve problems.
6. Reconstruct hydrocarbon reserves based on the appropriate data.
7. Relate the theories and principles of geology to the exploration of reserves and mineral deposits, and to problem solving in geological engineering.
8. Solve problems in reserves, mineral deposits and geological engineering based on field and laboratory observations and the concepts studied.
9. Suitably transmit information, verbally, graphically and in writing, using modern information and communication technologies.
10. Work independently.

## Content

### Theory

1. Introduction
- 1.1. Definition
- 1.2. Classification
- 1.3. Economic context
- 1.4. Multiple Uses of Rocks and Industrial Minerals
- 1.5. Economic considerations
- 1.6. Environmental considerations

## 1.7. Industrial Rocks and Minerals in the Iberian Peninsula

## 2. Industrial Rocks

### 2.1. Natural and dimension stone

### 2.2. Aggregates

### 2.3. Clays

### 2.4 Binders: cement, lime and plaster

## 3. Industrial minerals

### 3.1. Introduction: definitions, classification, economic importance and aspects of the market

### 3.2. Exploration and Evaluation of Industrial Minerals

### 3.3. Borates

### 3.4. Feldspat

### 3.5. Mica

### 3.6. Fluorite

### 3.7. Barita

### 3.8. Talc

### 3.9. Zeolites

\*\* Depending on the context of teaching development, a subset of these minerals may be taught. Each covers aspects of: Introduction, History, Production, Geology and Mineralogy, Specific Exploration Methods, Extraction and Processing Technologies, Industrial Uses, Specific Environmental Regulations and Considerations, and Specific Market Predictions and Trends.

## 4. Heritage Rocks

### 4.1. Classic sculptural and architectural heritage

### 4.2. Rocks from Catalan Archytectural Heritage

### 4.3. White marbles Identification techniques

### 4.4. Problems related to degradation of heritage rocks

## Practical Sessions

- As a possibility, a course work done in group of students can be set on some aspect of industrial rocks or minerals according to a list that will be proposed by teachers. It is established as a possibility that the work be presented in class in Power-Point format or as Poster (the decided format will be communicated at the beggining of the semester) or only in written format. In any case, it must be presented in written form (in paper copy plus pdf file). The work must contain the parts: index, Introduction, historical summary of the use of the

material, Exploration methods, Main present uses and applications, instrumental techniques related to the study and / or identification and / or evaluation of quality in the material , methods of exploitation, processes of manufacture of their industrial applications, environmental aspects and of sustainability, economic and market aspects and Bibliography and references or web links. There is logically flexibility to add or cancel some of the items to be treated, to adapt to the type of material studied at work. The list of specific topics to choose from will be communicated in the first weeks of the course. A deadline will be established for the working groups to be formed and communicated to the teacher (members of the group and chosen subject). The topics worked during the previous year can not be chosen during the current course.

Practical sessions / exercises on spetial cases will be developed the classroom or computer room. The contents will be considered among the following:

- Prospection and exploration (data interpretation of remote sensors, geophysical, geochemical or sounding testimonies)

- Geostatistics

- Operative methods (rock quarries, aggregate quarries, open pit or underground mining operations)

- Environmental impact and restoration of land after open pit or underground mining operations.

- Manufacture of an Industrial Rock or examples of treatment plants.

- Techniques for characterization of industrial minerals and rocks (RX difraction, particle size and shape, thermal analysis, vibrational spectroscopy, Electron microprobe analysis, Image analysis).

- Visual identification of heritage rocks, for example exercises on the identification of marbles using C and O isotopes of or by X-ray diffraction.

- methods for testing of properties of industrial rocks . UNE Normative quality standards.

## **Methodology**

Theory:

Magistral lectures.

In any case, the contents will be provided in advance through the Moodle Virtual Campus. The contents will be expanded as far as possible through web links. The contents will be provided prior to theoretical explanation sessions on essential aspects and resolution of doubts that will be carried out in person or virtually in the scheduled theoretical classes of the subject. A prior study by students is a must in order that the theoretical or doubt sessions to be fruitful. In addition, Question and Answer Forums will be established on theoretical topics.

Practicals:

In class with some exercises on various aspects related to the related practical issues. Practical exercises on the various aspects of the theoretical topics taught will be encouraged. In addition, forums will be also set up on practical topics.

Course work (in group of students):

Preparation throughout the semester, with a follow-up by teachers on demand from students (1 tutorial). The teacher may indicate the obligation or not to do this work and / or to make his presentation either with Power Point or Poster (will be communicated) in addition to written format. In this case both presentations will be evaluated.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

## Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practices	14	0.56	4, 3, 7, 6, 1, 9, 10, 2
Theory	20	0.8	4, 3, 7, 6, 9, 2
Type: Supervised			
Supervision of individual / grup work	7	0.28	4, 3, 7, 6, 9, 10, 2
Type: Autonomous			
Study, search for bibliographic information	50	2	4, 3, 7, 6, 9, 10, 2

## Assessment

Continuous assessment (AC): 2 partial exams

There will be 2 partial exams. The assessment is 40% of the total grade, in each case. Each test may include theoretical and / or practical aspects. Each test will score on 10 pt):

1st partial exam: Industrial Rocks ± Heritage Rocks. Theoretical and practical contents. Weight: 40% total grade AC

2nd partial exam: Industrial Minerals ± Heritage Rocks. Theoretical and practical contents. Weight. 40% total grade AC

The student who presents to one of the partial ones will not be able to opt to the qualification "not presented", since each partial one weighs in an amount  $\geq 35\%$ .

1st Partial Exam: consists of 3 parts: 1: Industrial Rocks\_1 (test), 2: Industrial Rocks\_2 (short questions of various formats) 3: Heritage Rocks. Held on Friday 24/04/2020. Rating on 10 points. The weighting of the parts is: 1: 25% -2: 25% -3: 50%. 40% of the continuous assessment mark.

2nd Partial Exam: with 2 parts: 1. Industrial Minerals + Practices 3 and 4 \_1 (test) 2. Industrial Minerals + Practices 3 and 4 \_2 (short questions of varied format). Rating on 10 points. The weighting of the parts is 1: 50%, 2: 50%. 40% of the continuous assessment mark.

The mark obtained in these partial exams will be complemented with the marks obtained in the exercises or theoretical or practical problems that may be raised with a fixed date of presentation also mandatory prior to the date of each partial examination. In the case of the first exam, the mark will be modified according to the following scale: 1st Partial mark = 15% Practica\_1 delivery mark -15% Practica\_2 delivery mark - 70% exam mark.

In the case of the second exam, the mark will be modified according to the following scale: 15% Practica\_3 delivery mark - 15% Practica\_4 delivery mark - 70% exam mark.

For the written work, the effort in the search for quality information, the degree of own elaboration of the content, spelling correction, care in the presentation, degree of group coordination and explication of all the credits of the materials used will be particularly valued (any work that does not contain ALL the duly accredited

figures -author / s name and year of publication + citation in the bibliography and all citations in the bibliography section duly inserted in the text, may eventually be considered failed). The evaluation of this work will be 20% of the continuous evaluation mark. In case of non- assignment of this work, the marks of the partial exams will be weighted 0.5 instead of 0.4.

-Continuous assessment grade (grade AC) = (Grade 1 partial x 0.4) + (Grade 2 partial x 0.4) + (Grade Work contents x 0.1 or 0.2 -If there is no exposure -) + (Note Exhibition work x 0.1 or 0 if there is no exhibition)

To pass the subject (passed) for continuous assessment, the AC mark must be equal to or greater than or equal to 5 and the marks for each part must be higher than 3. The marks lower than 3 in a partial prevent the calculation of the AC mark. (not assessable)  
and the student must appear in the corresponding part of the final recovery test.

Final test:

It will be necessary to recover any partial in which the qualification has been less than or equal to 3. The final test will consist of two parts: Recovery of Partial 1: INDUSTRIALROCKS ± HERITAGE ROCKS and Recovery of partial 2: INDUSTRIAL MINERALS ± HERITAGE ROCKS.

It will be possible to do either of the two parts (or both) to improve the final note of the asignatura. In the event that a lower grade is obtained than that obtained in the corresponding part, the higher grade will be maintained. If in any of the parts the mark is still lower than 3, the final grade will be suspended (in case of an average higher than 5 the mark will be reduced in this case to 4.9).

It will be necessary to notify in advance about the part or parts of the final test that will be done. The teacher will implement a list with a registration deadline for this exam. Students who have not passed the CA have the obligation to take the final test (partials not passed) and do not need to be notified to take this final test. Students who present themselves to improve their mark do have the obligation to notify and in the event that they do not do so, they may be excluded from the test for which they have not notified within the stipulated time.

In no case will there be a second final test of recovery, except for students who for a major and documented reason have not been able to attend any of the partials or recoveries.

All exams will consist of a test-type part with multiple-choice questions and a short-answer question section. For the objective part of the test-type part: Valid answered option: 1pt, unanswered option: 0pt, incorrect answered option: (- 0.25pt).

## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
1st Exam	40% of total EC grade	2	0.08	4, 3, 7, 6, 8, 9, 10, 2
2n Exam	40% of total EC grade	5	0.2	5, 4, 3, 7, 6, 1, 9, 10, 2
Final Exam	The same as each previous exams	2	0.08	4, 3, 7, 6, 8, 9, 10, 2
Oral (ppt or poster) presentation	20 %	0	0	4, 3, 7, 6, 9, 10, 2

## Bibliography

Àlvarez A., Domènech A., Lapuente P., Pitarch A., Royo H., (2009) Marbles and Stones of Hispania. Exhibition catalogue. Edited by Institut Català d'Arqueologia Clàssica (ICAC)

Bustillo, M., Calvo, J.P. & Fueyo, L. (2001). *Rocas industriales. Tipología, aplicaciones en la construcción y empresas del sector*. Editorial Rocas y Minerales. Madrid.

Carr, Donald D. (editor) (1994). *Industrial Mineral and Rocks*. 6a edició. Society for mining, Metallurgy, and Exploration, Inc. Littleton, Colorado (USA).

Elzea Kogel, J. et. al., (eds.) (2006). *Industrial Minerals and Rocks: Commodities, Markets, and Users*. 7a edició. Society for Mining, Metallurgy, and Exploration, Inc. Nova York.

Gutiérrez, A., (2009) Quarries in the Northeast of Hispania. Documenta 10, ICAC.

Lopez Gimeno, C., (1995). Manual de Rocas Ornamentales. Prospección. Explotación. Elaboración. ETS de Ingenieros de Minas de Madrid. LOEMCO. Ed. Entorno Gráfico S.L.

Herz N., Waelkens M., (eds.), (1988). Classical marble : geochemistry, technology, trade. Kluwer Academic Publishers, 1988

Regueiro, M. & Lombardero, M. (1997). *Innovaciones y avances en el sector de las rocas y minerales industriales*. Ilustre Colegio Oficial de Geólogos de España. Madrid.

Principal web links (others will be given and used during the semester):

[-Industrial Mineral Association EUROPE](#)

<http://www.ima-europe.eu/>

[-Industrial Mineral Association of N. America](#)

<http://www.ima-na.org/index.asp>

[-New Zealand Mineral Industry Association](#)

<http://www.minerals.co.nz/html/index.html>

[-Seminarios de la SEM \(Sociedad Española de Mineralogía\)](#)

<http://www.ehu.es/sem/revista/seminarios.htm>

[-IGME-DIR.GRAL.POLITICA ENERGETICA Y MINAS: PANORAMA MINERO](#)

<http://www.igme.es/internet/PanoramaMinero/PMLin.htm>

- <http://www.oum.ox.ac.uk/corsi/catalogue/classi>

Corsi Collection of Decorative Stones.

## **Software**

No specific software is required.