Departamento de Geologia

MINERAL RESOURCES AND ENVIRONMENTAL IMPACT

DISCIPLINE FILE

1 – Name, Credits and Functioning	
Discipline	Mineral Resources and Environmental Impact
Degree(s)	Geology (obligatory discipline)
Level [i] / Positioning in the Curricular Plan	3/ 3th year, 6º semester
Credits *(European Credit Transfer System)*	6 (4 of Lectures + 2 of Lab work)
Teaching (during 15 weeks)	30 h + 45 h (2 h Lect + 3 h Lab per week)
Tutorial hours (during 15 weeks)	15 h (1 h per week)
Required time for learning (school semester)	78 h (including the time needed for assessment preparation)

2 – Rationale / Objectives (200 words maximum)

Though firstly designed to students of the two courses indicated above, the discipline can also be attended by other students possessing adequate basic competencies in geology, who might be interested in the issues related with sustainable usage of mineral and energy resources and its relationships with economic and social development. The main topics of the discipline can be summarized as follows: (1) mineral and energy resources: major typologies and most common methods of characterization, exploration and exploitation; (2) principal factors determining the exploration and production costs for metallic and non-metallic raw materials, and their commercial value; (3) science and technology *versus* ore feasibility; (4) social and environmental impacts of the exploitation of metallic and non-metallic resources: how to characterize, monitoring and mitigate negative environmental impacts.

3 – Background requirements (70 words maximum)

The discipline requires no other background knowledge than the concepts, methods and general competencies transmitted/acquired in the disciplines of levels 1 and 2, which should have been completed prior to this semester.

4 – Syllabus Plan and Content (250 words maximum)

Lecture Programme

I – Mineral and Energy Resources: classification; geological assessment; historical overview and fundamental importance for human kind; the complex interdependence with economy, science, technology, politics, sociology and environment.

II – Metallic resources: 1) Present needs and evaluation of future demands; the dynamic concept of ore reserves; factors that determine the economic feasibility of a known resource; 2) Scarce metals: characteristics and main problems involved in its exploitation; 3) Igneous, metamorphic and sedimentary processes leading to metal concentration; 4) the major ore-forming processes; main types of ore deposits in relation to plate-tectonic settings; ore deposit research, the link between science and mineral industry; 5) Major metallic resources in Portugal; 6) The Neves Corvo and the Panasqueira deposits.

III – Non-metallic resources: 1) The main sources of non-metallic raw-materials and general problems related with their usage; 2) Production, consumption, applications and economic potential of the main types of building materials, ornamental rocks and industrial minerals; 3) Geographical distribution of some non-metallic resources of high unitary value; geological constraints and social-economic repercussions; 4) Major non-metallic resources in Portugal.

IV – Energy Resources: 1) Production and consumption of energy, an historical and geographical approach; 2) Fossil

energies - oil and coal: geological aspects of their genesis and exploitation; 3) Nuclear energy – fission and fusion: the concepts and mechanisms, the pros and the cons; 4) Geothermal energy: potential, geological constraints and economic significance; 5) Renewable forms of energy - hydroelectric power, wind, waves, tides, solar and hydrogen: present significance and future potential; geological aspects of energy: does alternative exists ?

V – Mineral exploration – brief introduction to some geological and geophysical methods of exploration; case studies in mineral exploration; the examples of the Iberian Pyrite Belt.

VI – Social and environmental impacts: 1) mineral industry and environmental policies; the major problems of the past and the present-day solutions to sort them out; acid drainage: wetlands and other remediation techniques; 2) burning of fossil fuels, carbon dioxide increase in the atmosphere, the cycle of carbon and carbon sequestration processes; greenhouse effect, global warming and other climate changes; the Kyoto protocol; looking forward to a sustainable, environmentally-friend development; 3) Dangerous and harmless metals - some case studies and curious examples: the toxic mercury and the story of an aluminium can; 4) Diamonds and society: the symbol of love is a war maker; 5) China and global economy: mineral resources in a rapidly changing world.

Lab Programme

I – Reflected-light microscopy and optical properties of opaque minerals. Ore mineralogy, ore mineral associations, and interpretation of ore textures; practical aspects of the preparation of polished surfaces and polished thin sections.

II – Practical determination of some physical and chemical properties of ornamental rocks and industrial minerals that constrain their economic value

5 – Learning Outcomes / Competences [ii]

- Understanding the relationships amongst human society(ies), demographic growing and increasing consumption of mineral and energy resources.
- Understanding the past, present and future interdependences between mineral and energy resources and sustainable development.
- Knowing the main applications of the major raw-materials and their consumption trends
- Distinguishing the concepts of *Resource* and *Reserve* and understanding the dynamic interdependence in-between these concepts.
- Understanding the major igneous, metamorphic and sedimentary processes that lead to metal concentration in the earth crust.
- Identifying the major characteristics of the main types of metallic and non-metallic mineral resources, namely the ones existing in the Portuguese territory.
- Understanding the geological controls over the spatial distribution of mineral resources in our country, as well as their current economic relevance and future trends.
- Identifying the main factors accounting for the energy dependence of modern society, and evaluating the potential role of the renewable forms of energy as alternatives either to fossil fuels or nuclear power.
- Knowing the main geological aspects of coal and oil formation.
- Knowing the major geological and geophysical exploration methods and understanding the criteria that determine their choice as a function of the physical and chemical characteristics of the resource considered, and/or of external factors such as geomorphology, climate, logistics, cost, etc.
- Understanding the physical and chemical parameters that quantitatively allow one to evaluate the environmental impacts of mineral industry; identifying the main types of negative impacts arising from mining activity and exploitation of non-metallic raw materials, and knowing how to monitoring and mitigating them.
- Knowing how to characterize and identify opaque minerals under the metallographic microscope; interpreting common ore microtextures.
- Knowing how to determine some physical and chemical properties of ornamental rocks and industrial minerals, which constrain their economic value

6 – Indicative reading list (text books and supplementary sources of information)

Major

	• Craig J.R., Vaughan D.J., Skinner B.J. (1996). *Resources of the Earth.* 2nd ed., Prentice Hall, Upper Saddle River, New Jersey, 472 p. • Evans A. M. (1997). *An Introduction to Economic Geology and Its Environmental Impact*. Blackwell Science, London, 364 p. • Craig J. R., Vaughan D. J. (1994). *Ore Microscopy and Ore Petrography*. 2nd ed., John Wiley & Sons, New York, 434 p. • Skinner B. J. (1986). *Earth Resources*. 3rd ed., Prentice Hall, Englewood Cliffs, New Jersey, 184 p • Marjoribanks R. (1997. *Geological Methods in Mineral Exploration and Mining.* Chapman & Hall, London, 115 p. • The Open University Science Course Block 6 (1982). *Crustal Anomalies; economic deposits and pollutants*. The Open University Press, Walton Hall, Milton Keynes, 101 p.
Additional	
	• Selected texts on specific topics that are not properly covered in the reference books indicated (e.g., Portuguese examples). • Compilations of scientific articles on particular case studies namely devoted to Portuguese examples.

7 – Other Elements of Study and Classroom Guiding
Lectures
• Detailed summaries of lectures, study guides and self-evaluation forms
Labs
• Introductory texts for practical works • Tables for Microscopic Identification of Ore Minerals (Economic Geology) • Ramdohr P. (1969). *The Ore Minerals and Their Intergrowths*. 2nd ed., Pergamon Press, Oxford, 1205 pp. ♦
♦ Available for use in Lab sessions.

8 – Assessment	
	Relative Weight in the Final Grade (%)
Alternative 1 (*)	
• Formative Assessment	
o 4 Self-evaluation forms (lecture programme)	10
o 9 Lab works	50
• Summative Assessment	
o 2 interim tests including multiple choice and constructed (short and long written) responses of questions regarding the lecture programme.	40
Alternative 2	
• Final Examination (**)	100
(*) Continuous assessment and tutorial work that measure the individual student progress during the school semester. In each component, students must demonstrate an acceptable level of achievement of the course outcomes, *i.e.* a threshold criterion of 50% of the respective mark. (**) It consists of a mixture of selected (multiple choice) and constructed (short and long written) response items plus X questions concerning Lab problems (numerical performance and results discussion).	

[i] Both Degrees (in *Geology and Natural Resources* and in *Applied Geology and Environment*) have a curricular programme of 8 semesters (4 years long). Disciplines included in these programmes are ordered according to a gradual and coherent sequence of levels (1 to 4) that follow a framework of learning outcomes, recognising a student progression characterised by an increase of its autonomy and of the responsibility that is expected of the learner in the guidance given and the tasks set. Disciplines of level 1 assume no previous knowledge of Geology, thus having an introductory (and transversal) character. Disciplines of level 2 provide an essential grounding in many fundamental concepts and techniques common to all branches of Geology. Disciplines of level 3 offer a core programme of advanced and integrative topics oriented to: (1) the manipulation of relatively complex database and production of simple numerical modelling included in quantitative approaches to common problems in Geology; and (2) the use of key-concepts in solving either transversal problems (eventually as a project work) or specific issues

preferentially dealing with questions directly related to the course (Degree) objectives. Disciplines of level 4 are designed in order to favour the consolidation of the professional profile defined for the course (Degree) and should also include advanced themes of synthesis demanding the rational use of the knowledge obtained along the entire learning path.

[ii] Learning outcomes are here used in the sense given by the glossary of the *Tuning Educational Structures*, i.e.: (…) *statements of what learner is expected to know, understand and/or be able to demonstrate* (and do) *after a completion of a process of learning* (…). Therefore, competences represent a combination of attributes (broadly referring to aptitude, proficiency, capability, skills and understanding, *etc.*) that reflect the qualification (degree or extent) to which a person is able of performing them.