Universitat Autònoma de Barcelona

2019/2020

Metamorphic Petrology

Code: 101057
ECTS Credits: 6

Degree	Type	Year	Semester
2500254 Geology	OB	3	2

Contact

Name: Joan Reche Estrada
Email: Joan.Reche@uab.cat

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

Teachers

Gisela Leoz Munte

Prerequisites

Remarcably, students must have acquired the previous competences related to previous matters as Fundamentals of Geology, Chemistry, Physics, Mathematics, Mineralogy, Petrology (Sedimentary and Igneous), Geochemistry and Structural Geology I.

In particular, the following concepts are recommended to be fresh:

- A basic knowledge on the Earth internal structure, Minerals and Rocks, Internal Geological Processes, Metamorphism and Magmatism
- Fundamentals of Thermodynamics and Chemical Kinetics, in particular those related to solid-solid reactions or basic phase diagrams knowledge
- Energy in the form of work and heat and temperature
- The systems of equations, matrix algebra and calculus (functions and their derivation and integration)
- The composition, crystal Structure and crystal-chemistry of the main rock forming Minerals and its main genetic environments
- Basic concepts in Optical mineralogy
- The classification, nomenclature, main mineralogical, textural and geochemical characteristics and the genesis of the main igneous and sedimentary rocks
- The geochemistry of diagenetic and endogenous processes (magmatic, metamorphic and interaction between fluids and rocks at high pressures and temperatures, Stress-strain relationships, rheology, main characteristics of the fragile and ductile regimes of deformation and the different structures related to both regimes, their description at different scales and their graphical representation through schemes or maps.

Objectives and Contextualisation

The main objectives of the subject are:

Learn the characteristics of metamorphism and metamorphic rocks: m

Learn to classify and name the different types of metamorphism and m
Learn the basics of the modern methods in Metamorphic Petrology an
Learn to identify and interpret the microstructures of metamorphic rock
Learn the different processes and factors that characterize petrogenes
Learn to identify the different types of metamorphic rocks in hand sam
Learn to describe and represent graphically and interpret the petrogra
Learn the basics of the integration of observation data with petrogenet

- Theory: Unit I- To have a global vision of metamorphic phenomena, emphasizing the following aspects: definitio ture, coexistence withfluids and kinetic variables. To know the basics of the nomenclature of the metamorphic roc non-observable variables such as pressure and temperature of formation, age of metamorphism and characterist

- Laboratory Practicals: Know how to recognize metamorphic minerals (m
- Field Practicals: Know the fundamental tools of the field study of metam

Competences

- Draw up and interpret geological maps and other means of depicting geological information (columns, correlation frames, geological cross-sections, etc.)
- Identify and characterise minerals and rocks through instrumental techniques, determine their formation environments and know their industrial applications.
- Learn and apply the knowledge acquired, and use it to solve problems.
- Process, interpret and present laboratory data using qualitative and quantitative techniques, and suitable computer programmes.
- Show an interest in quality and incorporate it into practice.
- Suitably transmit information, verbally, graphically and in writing, using modern information and communication technologies.
- Synthesise and analyse information critically.
- Work independently.

Learning Outcomes

1. Learn and apply the knowledge acquired, and use it to solve problems.
2. Present arguments based on phase diagrams.
3. Recognise the principal types of rocks in hand specimen and using a petrographic microscope.
4. Relate each type of rock to its genesis and the temporal dimension.
5. Relate field observations of minerals and rocks to laboratory observations and to genetic theory, based on the textures.
6. Show an interest in quality and incorporate it into practice.
7. Suitably transmit information, verbally, graphically and in writing, using modern information and communication technologies.
8. Synthesise and analyse information critically.
9. Work independently.

Content

THEORY:

Unit I. Fundamentals

L1. Metamorphism (1.5h). Definition. General context. Limits. Causes: st
L2. Types of metamorphism (4h). Relationship with plate tectonics. Regic
L3. Metamorphic Rock Nomenclature (2h). Basic structure. Terms referri
L4. Methodology * (1h). Summary of the history of the Metamorphic Petr

Unit II. Factors and variables of metamorphism

L5. Texture and Fabric (2h). Introduction: definitions and nomenclature. M

L6. The mineral assemblage (4h). Definitions. Mineral equilibria: Evidence. The Phase rule. The mineral composi
omponents. Mode. The relationship between mode, mineral composition and bulk composition. Representation: c

L7. Pressure, temperature and time (P-T-t) (2h). Lithostatic pressure vs.
L8. Fluids (2h). Introduction. Importance. Evidences of its existence durir

Practical classes:

Unit I. Microstructures of metamorphic rocks

Practical 1. Granoblastic microstructures (2h). Procedures for textural an
Practical 2. Reation microstructures (2h). Compositional zonning in meta
Practical 3. Deformational microstructures (2h). Oriented Granoblastic. L

Unit II. Metamorphic Rocks

Practical 4. Metabasites (4h). NCFMASH system and ACF diagram. Petr
Practical 5. Metapelites (4h). KFMASH system and influence of other ele
Practical 6. Quartz-feldspatic rocks (2h). KNASH system. AKN Diagram.
Practical 7. Marbres and Calcsilicate rocks (2h). CMS-HC system. CMS

Methodology

Guided activities:

Theory:

The main method of the classes will be Master Lessons. It is of the utmos

Practical classes:

They consist of studying a set of petrographic thin setions and metamorp
coupled to the teacher's microscop is eventually use and b) the students perform systematic observations of mine

Field Practice:

A full day field trip with observation of main characteristics of the metamo

ie. non-justified absence in 4 or more practical classes or systematic non-atendance in theoretical classes). Non-

Supervised activities:

Tutorials: students have the possibility to arrange (e-mail) personalized t
with the teacher or to make them using the communication tools of the Moodle virtual campus.

Work on a topic in group:
Group work on different aspects of the metamorphic rock outcrops to visi

Autonomous Activity:

It is recommended that the student dedicate a minimum of 80 hours thro

Virtual Campus (CV) - Moodle Classroom:

It is mainly about providing students with new connections with the subje
and practical classes, giving the possibility of connecting with subject contents during autonomous work time, pro

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Field trip	7	0.28	8, 1, 6, 5
Practices	20	0.8	8, 1, 6, 2, 3, 5, 7, 9
Theory	24	0.96	8, 2, 4, 5
Type: Supervised			
Group work controls or tutorials (desk C2/162)	0	0	8, 1, 6, 7, 9
Type: Autonomous			
Study, reading, confection of grup work, autoevaluation through CV	86	3.44	8, 1, 6, 2, 3, 4, 5, 7, 9

Assessment

The learning results are evaluated with CONTINUOUS EVALUATION (CA). The presentation to 35% of the CA, i

CONTINUOUS EVALUATION (CE):

1. THEORY:

Qualification of two partial Theory exams. Each will consist of two parts:
The weighting of each theoretical exam is 20% of the CE.

2. PRACTICALS:

a) Qualification of two partial exams. In the first exam students will have t
The weighting of each practical exam is 15% of the CE.

b) Qualification of two Dossiers of Practicals. The dossiers must be submitted at the same time the correspondin
The Dossiers must contain the minimum descriptions detailed below:
Practical 1: Textural layout and description (texture) of 1 thin section hav
Practical 2: Description and textural scheme of 1 thin section Reaction te
Practical 3: Description and textural scheme of 1 thin section with deform
Practical 4: Description of the mineralogy, microstructure and classificatio
Practical 5: Description of the mineralogy, microstructure and classificatio
Practical 6: Description of the mineralogy, microstructure and classificatio
Practical 7: Description of the mineralogy, microstructure and classificatio

The final part of the dossier must also contain the reasoned solution of the exercises / problems or tests that have
Drawing schemes will be done in practice class sessions and can be con
The weighting of each dossier is 5% of the CE.

c) Qualification of attendance to the Practices.
It will be assessed through a signature control at the end of each practice
The weighting of the attendance to the practices is 2.5% of the CE. The t

3. FIELD:

The evaluation of the field contents involves the following:
a) Field test / exams that will be incorporated into the second exam. Weig
b) Qualification of group work contents, after its presentation in written fo
c) Qualification of the oral or written (poster) presentation (about 15 ') of t

The FINAL QUALIFICATION FOR CONTINUOUS EVALUATION (AC): is obtained as a result of the following we
on 10 points basis)x (0.15)] + [
Practice exam 2
on 10 points basis) x (0.15)] + dossier 1 (

on 10 points basis) x (0.05)] + [dossier 2 (

on 10 points basis) x (0.05)] + [practice attendance (

on 10 points basis) x (0.025)] + [field TEST (

on 10 points basis) x (0.05)] + [qualification of group work contents (

on 10 points basis) x (0.075)] + [ORAL PRESENTATION (

on 10 points basis) x (0.05)]. The minimum mark of any of the partial theory or practices in order to be able to do

FINAL EXAM: Students who have not passed the subject on CE or those who have passed but want to have an

The FINAL QUALIFICATION l is obtained as a result of the following weighting: [mark on theory (on 10 points bas
on 10 point basis) x (0.10) + [group work (
on 10 point basis) x (0.05) + [oral presentation of group work (
on 10 point basis x (0.05)]. The minimum mark of the parts of theory or practices to be able to do the previous we
For the previous calculations, any non-presented equals a mark of 0. The

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
1st Dossier / exercices	5	0	0	8, 1, 6, 3, 5, 7, 9
1st Exam Practices	15	2	0.08	1, 6, 5, 7
1st Exam Theory	20	2	0.08	8, 1, 6, 4, 5, 7
2n Exam Practices / Excercices	15	2	0.08	8, 1, 6, 2, 3, 5, 7
2n Exam Practices / Excercices	5	0	0	8, 1, 6, 2, 3, 5, 7, 9

2n Exam Theory	20	2	0.08	8, 1, 6, 2, 4, 5, 7
Assistance to Practices	2,5	0	0	8, 1, 6, 2, 3, 5, 7
Group work contents (matter related to the field trip)	7,5	0	0	6, 7
Oral presentation or submission in pdf (electronic format 15') of course work in group	5	4	0.16	8, 1, 6, 2, 4, 5, 7, 9
Test/Fied exam	5	1	0.04	8, 1, 6, 3, 5, 7

Bibliography

Theory

Best, M.G., (1982). *Igneous and Metamorphic Petrology*. W.H. Freeman & Company. San Francisco.

Bucher, K. & Frey, M. (2002). *Petrogenesis of Metamorphic Rocks*. 7th Edition, Springer-Verlag.

*Fettes, D. & Desmonds, J. (eds), (2007). Metamorphic Rocks: A classification and Glossary of Terms. Recomendations of the international Union of Geological Sciences Subcommission on the Systematics of Metamorphic Rocks. Cambridge U. Press.

Mason, R., (1990). *Petrology of the Metamorphic Rocks*. Second ed. Unwin Hyman. Londres.

*Miyashiro, A., (1994). *Metamorphic Petrology*. UCL Press. Londres.

Spear, F.*S., (1993). Metamorphic Phase Equilibria and Pressure - Temperature - time Paths.* Mineralogical Society of America monograph.Whashington DC.

Philpotts, A.R., (1990). *Principles of Igneous and Metamorphic Petrology.* Prentice Hall.

Vernon, R.H., (2008), Principles of Metamorphic Petrology. Cambridge University Press.

*Winter, J.D., (2001). *An Introduction to Igneous and Metamorphic Petrology.* Prentice Hall.

Yardley, B.W.D. (1989). *An Introduction to Metamorphic Petrology.* Longman Earth Science Series. John Wiley & Sons, Inc. Nova York.

Practices

Barker, A.J., (1990*). Introduction to Metamorphic Textures and Microestructures*. Blackie & Son. Nova York.

*Nesse, W., (2004). Introduction to Optical Mineralogy. 3rd. Edition. Oxford University Press.

Spry, A., (1969). *Metamorphic Textures*. PergamonPress. Oxford.

*Vernon,R., (2004). *A practical Guide to Rock Microstructure.* Cambridge University Press.

*Yardley, B.W.D., Mackenzie, W.S. y Guilford, C.(1990). *Atlas of metamorphic rocks and their textures*. Longman Scientific & Technical.

* Preferent books to consult

web links

LES ROCHES METAMORPHIQUES : TEMOINS DE L'EVOLUTION THERMIQUE DE LA LITHOSPHERE DANS LE TEMPS ET DANS L'ESPACE

Classificació IUGS (SCMR) de les Roques Metamòrfiques

Igneous and Metamorphic Petrology class Materials. Winter, J. Whitman College.

Modelització analògica de Microestructures (University of Albany)

Atlas of Metamorphic Rocks, Minerals and Textures. Glazner and Ratajeski, University of N. Carolina