



## Course Book

<b>1. Course name</b>	Igneous and Metamorphic Petrology
<b>2. Lecturer in charge</b>	Mohammed Majeed Zrary (Ph.D.)
<b>3. Department/ College</b>	Department of Earth Sciences and Petroleum / College of Science
<b>4. Contact</b>	<b>e-mail:</b> <a href="mailto:mohammed.sofyissa@su.edu.krd">mohammed.sofyissa@su.edu.krd</a> <a href="mailto:mmzrary@gmail.com">mmzrary@gmail.com</a> <b>Tel:</b> 07504530336
<b>5. Time (in hours) per week</b>	<b>For Theory: 2</b> <b>Practical: 8</b>
<b>6. Office hours</b>	<b>7-8 hours</b>
<b>7. Course code</b>	
<b>8. Teacher's academic profile</b>	<p>* Graduated at the Department of Geology, Salahaddin University/College of Science (1992-1993).</p> <p>* I was engaged to work as an assistant geology on 1994 at Ministry of industry and energy at Erbil Geological Survey.</p> <p>* At 1998 which I followed the Salahaddin University/ College of Science as assistance researcher to 2000. When I work as assistance researcher, I contributed in teaching several practical geological subjects such as geomorphology, stratigraphy, geophysics, paleontology, mineralogy and general geology at this year I entered master courses and got it at 2003 from that year to now I teach courses in the Department of Geology such as Optical mineralogy, petrology, Geochemistry and igneous and metamorphic petrography.</p> <p>* M.Sc. in Igneous petrology and their minerals, Geology Department, College of Science, Salahaddin University-Erbil, Iraq.</p> <p>* Assistant lecturer in Geology Department, Salahaddin University-Erbil, teaching practical to undergraduate students in the laboratory of subjects: optical mineralogy and Igneous and Metamorphic Petrology.</p>

	<p>* Ph.D. in Igneous and Mineralogy Geochemistry, at the Department of Geology, College of Science, Mosul University.                  Since 2019 I worked as Lecturer in the Geology Department at Salahaddin University-Erbil, teaching theoretical courses to undergraduate students in igneous and metamorphic petrology.</p>
<p><b>9. Keywords</b></p>	<p>Science, Mineralogy, Petrology, Igneous, Metamorphic</p>
<p><b>10. Course overview:</b>                  Course overview:                   This course will cover most important topics of igneous and metamorphic petrology, which focuses on the origin, occurrence, structure, and history of igneous and metamorphic rocks. The course will cover the structure of inner earth with a focus on continental crust, oceanic crust and upper mantle as the main igneous and metamorphic processes take place there.                  The first part will concentrate on igneous rocks, their classifications, textures and different rocks types, while the second one will be on metamorphic rocks, their textures, rock types, classifications, metamorphic types and metamorphic facies.</p>	
<p><b>11. Course objective:</b>                  Regular attendance is the best way to assure a good grade in this class. Different form of teaching is illustrated to gain best results, and it is much easier to absorb the information in lecture than to try and learn it on your own from the text. As an incentive to come regularly, quizzes will be given every 2 lectures.                  The students will be able to understand the petrology of igneous and metamorphic rocks in hand specimen. Physical properties of different minerals, is the aim for understanding the name and the texture of the rocks.</p>	
<p><b>12. Student's obligation</b>                  In this course, the students will be required by two monthly exams, first at the middle of course, the second at the end of it. The student's obligation during the course is attendance in the class for three hours for studying the practical part and applies it in the laboratory. There are many samples of both igneous and metamorphic rocks in the lab. Students also will be required by weekly report about former laboratory they had taken. You can expect us to:                  Be interested, excited, and enthusiastic about the course and the material</p> <ul style="list-style-type: none"> <li>• Take a new and innovative approach to teaching this course</li> <li>• Try to convince you that the material in this course is worth knowing</li> <li>• Assume you are familiar with the chapter before we discuss it in class</li> <li>• Include material that is not in the text and for which you will be responsible</li> <li>• Challenge you to think about the material and to evaluate situations</li> <li>• Involve you in the material through in-class and out-of-class exercises</li> </ul>	

- start and end class on time

We expect you to:

- Come to class regularly.
- Be willing to become involved in the course.
- Be an active and receptive learner.
- Read the chapter before class and consider specific concepts and questions.
- Complete on-line exercises and quizzes.
- Collaborate with your neighbours to exchange ideas and learn new concepts.
- Hand in your own work on the in-class exercises.
- Be courteous to me and to your classmates.

### 13. Forms of teaching

Different forms of teaching will be used to reach the objectives of the course: power point presentation will illustrate to show the main point slide titles and definitions and summary of conclusions, white board to clarify ideas, office work by designing work sheet to solve and analyse CIPW problems and homework's, all figures that related to the lectures.

To get the best of the course, it is suggested that you attend classes as much as possible, read the required lectures before the time of lecture, teacher's notes regularly as all of them are foundations for the course.

Try as much as possible to participate in classroom discussions.

### 14. Assessment scheme

Breakdown of overall assessment and examination

The students are required to do an one theoretical exam at the end of the semester. The semester has %15 marks for theory, and 35% for practical so we divided it like that: 5 for quizzes and weekly work report of lab work 5% and the term exam of lab have 25 marks.

There will be a final exam on 50 so the final grade will be upon the following criteria:

The course mark for theory: 15% (Midterm exam %10 Activities (%5))

Final exam for the semester: 50%, therefore, the total mark will be 65%.

The students are required to study practical on 35%marks, and the (**midterm exam %15, quizzes%6, weekly reports %8, Activities %6**) as result practical total mark is 35 %.

### 15. Student learning outcome:

- 1- The student should be able to understand the earth composition and the classification of its different parts according to seismic data.
- 2- The student should be able to understand the different physical properties of igneous and metamorphic rocks in hand specimens.
- 3- The student should be able to identify the different igneous and metamorphic rocks and their textures in hand specimens.
- 4- The student should be able to identify the different igneous and metamorphic structure in the field.
- 5- The student should be able to understand different tectonic environments associated with the different igneous and metamorphic rocks.
- 6- The student should be able to know the distribution of igneous and metamorphic rocks in Iraq.

### 16. Course Reading List and References:

Required books:

- Best, M.G. (2003): *Igneous and Metamorphic Petrology*: Blackwell Publishing company.
- Blatt, Harvey and Robert J. Tracy (2006) *Petrology: Igneous, Sedimentary, and Metamorphic*, W.H. Freeman & Company; 3rd ed.
- Loren A. Raymond. (2002) *The study of igneous, sedimentary and metamorphic rocks* 2nd ed.
- Nesse, William D (2018) *Introduction to mineralogy* (Oxford University Press) 3<sup>rd</sup> Edition 495p.
- Martin Okrusch, Hartwig E. Frimmel (2020) *Mineralogy An Introduction to Minerals, Rocks, and Mineral Deposits*, Springer Berlin Heidelberg Springer 719p.
- Tracy R. and Owens B., 2005. *Petrology: Igneous, Sedimentary, and Metamorphic*.
- Winter J. D. (2014) *Principles of Igneous and Metamorphic Petrology* (2nd ed.) 737p.

Students are encouraged to search for the Journals and internet that may help them in this course, such

as:

- 1) Contributions to Mineralogy and Petrology.
- 2) Journal of Petrology

<b>17. The Topics:</b>	<b>Lecturer's name</b>
The following subjects will cover the mentioned aims of the course (theoretical part):	Mohammed Majeed Zrary
Week 1: Introduction to igneous rocks	2 hours
Week 2: The Earth's Internal Structure	2 hours
Week 3: Textures of igneous rocks	2 hours
Week 4: Classifications of igneous rocks	2 hours
Week 5: Mineralogical classification of igneous rocks	2 hours
Week 6: Igneous rocks in the field and its structures	2 hours
Week 7: Introduction to metamorphic rocks	2 hours
Week 8: Types of the metamorphic rocks	2 hours
Week 9: Classification of metamorphic rocks	2 hours
Week 10: Igneous, metamorphic rocks and tectonics	2 hours
Week 11: Metamorphic rocks in the field	2 hours
Week 12: Distribution of igneous and metamorphic rocks in Iraq	2 hours
Week 13: Magma differentiation and Bowen reaction series	2 hours
Week 14: Igneous rocks of oceanic basins	2 hours
<b>18. Practical Topics (If there is any)</b>	
<b>Week 1:</b> CIPW Lab No.1	Mohammed Majeed Zrary
Definition and concept of CIPW and their steps for calculation	2 hours
<b>Week 1:</b> CIPW Lab No.1	2 hours
<b>Week 2:</b> CIPW Lab No.2	2 hours
<b>Week 3:</b> CIPW Lab No.3	2 hours

<b>Week 4:</b> Review of igneous and metamorphic rock forming minerals	2 hours
<b>Week 5:</b> Textures of igneous rocks	2 hours
<b>Week 6:</b> Classification of igneous rocks (basic & ultrabasic rock)	2 hours
<b>Week 7:</b> Classification of igneous rocks (Intermediate & acidic rock)	2 hours
<b>Week 8:</b> Contact metamorphic rock	2 hours
<b>Week 10:</b> Classification of igneous rocks (Intermediate & acidic rock)	2 hours
<b>Week 11:</b> Regional metamorphic dynamic and hydrothermal metamorphic rocks	2 hours
<b>Week 12:</b> Regional metamorphic dynamic and hydrothermal metamorphic rocks	
<b>19. Examinations:</b> Theory and practical Examples of exam	
<b>20. Extra notes:</b> The course book lacks to the problems which affect the educational process. These problems include the large number of students in each stage, diminution of instruments, and absence of appropriate rooms for lecturers to develop themselves. Finally, about the department of geology absence of financial support to carry out scientific trips and field course in a typical situation.	
<b>21. Peer review:</b> Assistant Prof. Dr. Ahmed Muhammed Aqrawi.	

Salahaddin University  
College of Science  
Department of Geology  
2<sup>nd</sup> Class



Monthly Examination of  
(Ign. & Met.) Petrology  
Date: 17/4/2023  
Time: 60 minutes

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**Q1)** choose the correct answer between brackets **“40 mark”**

1. Non-foliated rocks found in contact metamorphic aureoles are called (**granofels, hornfels, slate, petrofels**).
2. In the post metamorphic textures if the rock is highly strained and the matrix become glassy, the (**cataclasite, mylonite, serpentinites**) term is used.
3. (**Batholith, Stock, Lopolith, Laccolith**) are large discordant bodies (surface exposure > 100 km<sup>2</sup>) with dome-shaped roofs.
4. (**Pyroxene, Garnet, Muscovite**) is a hydrous mineral that eventually disappears at the highest grade of metamorphism.
5. (**Crater, Caldera, Volcano, Columnar Jointing**) is a depression near summit of volcano.
6. (**Low, Intermediate, High**) grade metamorphism takes place at temperatures between about 450 to 650°C.
7. Marble is a metamorphic rock composed of coarse-grained (**plagioclase, quartz, calcite**).
8. (**Metamorphism, Metasomatism**) water brings ions from outside the rock, and they are added to the rock during metamorphism. Other ions may be dissolved and removed.
9. In the (**slaty, schistose, gneissic**) texture of the metamorphic rocks, the sheet silicates become unstable and dark colored minerals like hornblende and pyroxene start to grow.
10. (**Lower limit, Upper limit**) of metamorphism is overlap with diagenesis processes of sedimentary rocks.





<p><b>Q1</b></p> <p>a- Crystallinity.....</p> <p>b- Mode of occurrence.....</p> <p>c- Granularity.....</p> <p>d- Color index.....</p>
<p><b>Q2</b></p> <p>a- Min. Com.....</p> <p>b- Granularity.....</p> <p>c- Acidity.....</p> <p>d- Acidity.....</p>
<p><b>Q3</b></p> <p>a- Met. Type.....</p> <p>b- Texture.....</p> <p>c- Parent rock.....</p> <p>d- Rock Name .....</p>
<p><b>Q4</b></p> <p>a- Min. Com.....</p> <p>b- Mutual relationship.....</p> <p>c- Mode of occurrence.....</p> <p>d- Rock Name.....</p>
<p><b>Q5</b></p> <p>a- Min Com.....</p> <p>b- Acidity.....</p> <p>c- Mode of occurrence .....</p> <p>d- Rock Name.....</p>

**Q6**

- a- Granularity.....
- b- Acidity.....
- c- Mode of occurrence.....
- d- Rock Name.....

**Q7**

- a- Met. Type.....
- b- Texture.....
- c- Parent rock.....
- d- Rock Name.....

**Q8**

- a- Met. Type.....
- b- Texture.....
- c- Met. Grade.....
- d- Parent rock.....

**Q9** Compare between X & Y in (1-Mutual relationship, 2-Acidity and 3- Mode of occurrence)

	X	Y
M		
A		
O		

**Q10**

- a-Classify igneous rocks according to “silica content”  
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- b-Mention texture types in regional metamorphism  
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