



Salahaddin University

College of Science

Department of Geology

Subject: Igneous and Metamorphic Petrology

Course Book: 2nd Year – 2nd Semester

Lecturer's names: Mohammed Majeed Zrary (Ph.D.)
(Theory) & (Practical)

Academic Year: 2023/2024

Course Book

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| 1. Course name | Igneous and Metamorphic Petrology |
| 2. Lecturer in charge | Mohammed Majeed Zrary (Ph.D.) |
| 3. Department/ College | Department of Geology / College of Science |
| 4. Contact | Email: mohammed.sofyissa@su.edu.krd mmzrary@gmail.com Mobile: 0750 453 0 336 |
| 5. Time (in hours) per week | Theory: 2 hours, Practical: 6 (2 Hours per group weekly) |
| 6. Office hours | Sunday: 8:30-10:30, 10:30-12:30, 12:30-2:30 Thursday: 10:30-12:30 |
| 7. Course code | |
| 8. Teacher's academic profile | <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.</p> <p>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> |

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| 9. Keywords | Science, Mineralogy, Petrology, Igneous, Metamorphic |
| <p>10. 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>11. Course objective: 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>12. Student's obligation 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:</p> <ul style="list-style-type: none"> · be interested, excited, and enthusiastic about the course and the material · take a new and innovative approach to teaching this course · try to convince you that the material in this course is worth knowing · assume you are familiar with the chapter before we discuss it in class · include material that is not in the text and for which you will be responsible · challenge you to think about the material and to evaluate situations · involve you in the material through in-class and out-of-class exercises · provide you with useful information on-line | |

- 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

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%

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 term exam on 23% marks 6% for quizzes and 6% lab work.

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. 728p.

Tracy R. and Owens B., 2005. Petrology: Igneous, Sedimentary, and Metamorphic.

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

17. The Topics:

Lecturer's name

In this section the lecturer shall write titles of all topics he/she is going to give during the term. This also includes a brief description of the objectives of each topic, date and time of the lecture
Each term should include not less than 16 weeks

The following subjects will cover the mentioned aims of the course (theoretical part):

Week 1: Introduction to igneous rocks

Week 2: The Earth's Internal Structure

Week 3: Textures of igneous rocks

Week 4: Classifications of igneous rocks

Week 5: Mineralogical classification of Igneous rocks

Week 6: Igneous rocks in the field and its structures

Week 7: Introduction to metamorphic rocks

Week 8: Types of the metamorphic rocks

Week 9: Classification of metamorphic rocks

Week 10: Igneous, metamorphic rocks and tectonics

Week 11: Metamorphic rocks in the field

Week 12: Distribution of igneous and metamorphic rocks in Iraq

Week 13: Magma differentiation and Bowen reaction series

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| | <p>Week 14: Igneous rocks of oceanic basins</p> <p>Week 15: Igneous rocks of convergent margins</p> <p>Week 16: Igneous rocks of continental lithosphere</p> |
| <p>18. Practical Topics (If there is any)</p> | |
| <p>This syllabus may be subject to changes, i.e., we may take either longer or shorter time to finish topics, and if any changes happened you will be notified well in advance.</p> | <p>Week 1: Review of igneous and metamorphic rock forming minerals</p> <p>Week 2: CIPW Lab No.1</p> <p>Week 3: CIPW Lab No.2</p> <p>Week 4: CIPW Lab No.3</p> <p>Week 5: CIPW Lab No.4</p> <p>Week 6: Textures of igneous rocks</p> <p>Week 7: Classification of igneous rocks (basic & ultrabasic rock)</p> <p>Week 8: Classification of igneous rocks (basic & ultrabasic rock)</p> <p>Week 9: Classification of igneous rocks (Intermediate & acidic rock)</p> <p>Week 10: Classification of igneous rocks (Intermediate & acidic rock)</p> <p>Week 11: Contact metamorphic rock</p> <p>Week 112: Regional metamorphic dynamic and hydrothermal metamorphic rocks</p> <p>Week 13: Regional metamorphic dynamic and hydrothermal metamorphic rocks</p> <p>Week 14: Tectonic environment of different igneous and metamorphic rocks</p> |
| <p>19. Examinations: Theory Examples</p> | |
| <p>20. Extra notes: 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.</p> | |
| <p>21. Peer review Assistant Prof. Dr. Ahmed Muhammed Aqrawi.</p> | |



Q1) A/ Give the mineralogical compositions of these rocks and give its equivalent “15 mark”

| | Rocks | Mineral composition | equivalent |
|---|----------------|---------------------|------------|
| 1 | Olivine gabbro | | |
| 2 | Trachyte | | |
| 3 | Diorite | | |
| 4 | Granite | | |
| 5 | Dacite | | |

B/ Give two examples for the following: (20 marks)

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| Feldspathoid minerals | |
| Pyroxene group | |
| Cavity and filling textures | |
| Ultrabasic rocks | |
| Pyroclastic rocks | |

Q2) Complete the following Sentences: (20 marks)

1- According to quartz saturation, igneous rocks classified into: **“6mark”**

.....

2- Phaneritic textures are divided to **“8mark”**

.....

3- Mention the discontinuity and their location in interior of earth **“6 mark”**

.....

Q3) Write the chemical formulas of the following minerals: (answer “5”) (10 marks)

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| Olivine | Orthoclase |
| Nepheline | Quartz |
| Albite | Calcite |

Choose the correct answer for the following sentences: **(20 marks)**

- 1- (**Lithosphere, Asthenosphere, Mesosphere**) is comprised of both crust and part of the upper mantle.
- 2- (**Diorite, Basalt, Granite, Rhyolite**) is a plutonic acidic igneous rock.
- 3- $[(Fe,Mg)_2SiO_4]$ is a chemical formula of (**hypersthene, olivine, orthoclase, nepheline**).
- 4- (**Lower crust, Upper crust**) composed largely of aluminium silicate minerals and is considered to be granodioritic to dioritic in composition.
- 5- (**Mesosphere, Outer Core, Inner core, Mantle**) about 2250 km thick S-wave velocities are zero in it.
- 6- Two-stage of cooling can create a (**equigranular, inequigranular**) texture.
- 7- (**Gutenberg, Moho, Lehmann, Conrad**) discontinuity represents the boundary between crust and mantle.
- 8- $[KAlSi_3O_8]$ is a chemical formula of (**quartz, orthoclase, calcite, nepheline**).
- 9- (**Gabbro, Granite, Basalt, Rhyolite**) is an intrusive basic rock.
- 10- In rapid (undercooling)cooling the crystallinity of rock is (**holohyaline, holocrystalline**).
- 11- (**Secondary, Primary**) textures occur during igneous crystallization and result from interactions between minerals and melt.
- 12- (**Parental magma, Derivative magmas, Primitive magmas, Primary Magma**) formed directly by partial melting of the mantle, without any later modification.
- 13- (**Phaneritic, Aphanitic**) textures: crystals visible to the naked eye.
- 14- (**Leucocratic, mesocratic, melanocratic, holomelanocratic” ultramafic”**) said of igneous rocks that consist of minimum mafic minerals.
- 15- (**Muscovite, Plagioclase, Quartz, Biotite**) is a mafic mineral.
- 16- Peralkaline is (**color index, silica content, alumina saturation, phaneritic**) classification for igneous rock.
- 17- (**Andesite, Trachyte, Obsidian**): is the volcanic rock that composed of glass entirely.
- 18- (**Equilibrium crystallization, Fractional crystallization**) Crystals that form remain in direct contact with melt
- 19- Rhyolitic magmas are abundant on the (**continental crust, oceanic crust, both oceanic and continental crust**).
- 20- Basaltic magma derived from the (**upper mantle, lower crust, outer core**).

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| <p><u>Q1</u> a- Mode of occurrence..... b- Crystallinity..... c- Mode of occurrence..... d- Acidity.....</p> | <p><u>Q6</u> a- Color index..... b- Granularity..... c- Mode of occurrence..... d- Rock name.....</p> |
| <p><u>Q2</u> a- Min. Com..... b- Color index..... c- Acidity..... d- Quartz content</p> | <p><u>Q7</u> a- Min. Com..... b- Met. type</p> <p>c- Parent rock</p> <p>d- Rock name.....</p> |
| <p><u>Q3</u> a- Min. Com</p> <p>b- Met. type</p> <p>c- Parent rock</p> <p>d- Rock name</p> | <p><u>Q8</u> a- Met. type.....</p> <p>b- Texture.....</p> <p>c- Met. grade.....</p> <p>d- Rock name.....</p> |
| <p><u>Q4</u> a- Granularity..... b- Crystallinity..... c- Mode of occurrence..... d- Rock name.....</p> | <p><u>Q9</u> a- Crystallinity..... b- Acidity..... c- Granularity..... d- Mutual relation.....</p> |
| <p><u>Q5</u> Classify igneous rocks according to “silica content”</p> | <p><u>Q10</u> Mention the types of textures found in foliation metamorphic rocks</p> |