



**NATIONAL UNIVERSITY OF ENGINEERING**  
**COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL**  
**ENGINEERING**

**GEOLOGICAL ENGINEERING PROGRAM**

---

**GE433 – PETROLOGY OF IGNEOUS AND METAMORPHIC ROCKS**

**I. GENERAL INFORMATION**

|                       |  |
|-----------------------|--|
| <b>CODE</b>           | : GE433 Petrology of Igneous and Metamorphic Rocks |
| <b>SEMESTER</b>       | : 7  |
| <b>CREDITS</b>        | : 4  |
| <b>HOURS PER WEEK</b> | : 6 (Theory–Practice–Laboratory)                   |
| <b>PREREQUISITES</b>  | : GE153 Petrography, GE155 Microscopy.             |
| <b>CONDITION</b>      | : Compulsory                                       |
| <b>DEPARTMENT</b>     | : Geological Engineering                           |

**II. COURSE DESCRIPTION**

The course prepares students for the analysis of the genesis of igneous and metamorphic rocks. The origin, classification, and occurrence of igneous and metamorphic rocks are analyzed. The petrography of igneous and metamorphic rocks is described at macroscopic and microscopic levels. Geophysical and geochemical properties of igneous and metamorphic rocks are analyzed and interpreted.

**III. COURSE OUTCOMES**

At the end of the course, students:

1. Organize the basic concepts and the phases of a petrologic study.
2. Applies to rocks the principles of chemical equilibrium and explain mineral associations as thermodynamic systems.
3. Understand and interpret the phase diagrams of mineral systems.
4. Explain the metamorphic processes and the degrees of rock metamorphism.
5. Analyze the properties and igneous and metamorphic rocks in Peruvian geological regions.

**IV. LEARNING UNITS**

**1. INTRODUCTION**

Basic concepts / Petrologic study phases / Documentation and study of the geological context / Fieldwork and sampling / Preliminary petrographic study / Petrographic descriptions / Study of chemical compositions / Study of isotopic compositions / Radiometry / Petrological interpretations / Geotectonic framework / Internal composition of the Earth / The Earth crust / Geotectonic environments / Composition of the Earth crust.

**2. IGNEOUS ROCKS NOMENCLATURE**

Igneous rocks and magma series nomenclature / Nomenclature of igneous rocks based on mineralogical composition / AQPFM diagrams / Classification of igneous rocks according to chemical composition / TAS, R1R2 diagrams / Petrographic rules / Magmatic series / TAS, KS, AFM diagrams / Geotectonic units and petrographic provinces / Kinetic and dynamic properties of magma / Physicochemical properties / Nature of silicate mergers / Water and CO<sub>2</sub> solubility / Molar volume and density / Viscosity / Kinetic of magma / Thermal diffusion / Chemical diffusion / Nucleation / Growth of crystals / Dynamics of magma / Diapirism / Dams / Laminar and turbulent flows / Flows in a permeable media / Differentiation mechanisms / Partial fusion / Fractional crystallization. / Detachment.

### **3. ASSOCIATIONS OF MINERALS AS THERMODYNAMICAL SYSTEMS**

Principles of chemical equilibrium applied to rocks / Definitions / Meaning of mineral stability and chemical balance / Phase rule.

### **4. DIAGRAMS**

Phase diagrams / Phase diagrams of mineralogical systems of igneous rocks / Diagrams of chemical variation / Data statistical treatment / Variations of major element. / Harper bivariate diagram / Triangular diagrams / Indexes / Trace elements variations / Distribution coefficients / Spider diagrams / Recognition of geotectonic units / Isotopic composition variations / Igneous rocks in Peru regions / Precambrian and Paleozoic / Permotriassic / Mesozoic and Cenozoic (Andean cycle).

### **5. INTRODUCTION TO THE PETROGRAPHY OF METAMORPHIC ROCKS**

Some definitions. / Limits of metamorphism. / Degrees of metamorphism.

### **6. TYPES OF METAMORPHISM**

Metamorphic processes / Assemblies graphic representations / Metamorphism of contact / Metamorphism of ultramafic rocks / Metamorphism of mafic rocks / Granitoids metamorphism / Metamorphism of limestones and dolomites / Metamorphism of pelitic rocks / Metamorphism of marl / Metamorphic rocks in Peru.

## **V. LABORATORY / PRACTICAL EXPERIENCES**

1. Practice 1: Mineralogy of igneous rocks / Macroscopic and microscopic recognition of minerals / Textures of igneous rocks. / Annex 1: Seminar of instrumental analysis.
2. Practice 2: Exercises of nomenclature depending on the chemical composition / Exercises of petrographic standards / Exercises of nomenclature depending on the mineralogy / Textures recognition.
3. Practice 3: Petrography of acid igneous rocks (intrusive and extrusive).
4. Practice 4: Exercises of phase diagram / Phases and textures diagrams / Petrography of intermediate igneous rocks (intrusive and extrusive) / Petrography of silica rocks / Harper diagrams of different units / Provinces / Spider diagrams of different units / Provinces / Isotopic diagrams of different units / Provinces / Petrography of basic and ultrabasic igneous rocks.
5. Practice 5: Peruvian petrographic provinces.
6. Practice 6: Classification of metamorphic rocks / Types of metamorphic protolith / Textures and metamorphic structures / Petrography of Hornfel / Petrography of serpentinites and eclogites / Petrography of schists and amphibolites.
7. Practice 7: Petrography of Gneis. / Petrography of marble. / Petrography of metapelite (slates, phyllites, schists). / Petrography of metamarl (slates, phyllites, schists).
8. Practice 8: Peruvian metamorphic terrains.

## **VI. METHODOLOGY**

The course will be taught under the modality consisting of theory, practice and computer laboratory sessions. In the theory sessions, the teacher presents concepts, theorems and applications. In the practice sessions, various problems are solved and their solution analyzed. At the end of the course the student should present and expose a project. Student's active participation is promoted.

## **VII. GRADING FORMULA**

The Final Grade PF is calculated as follow:

$$PF = PP$$

PP: Average of the best 75% of practical works.

## **VIII. BIBLIOGRAPHY**

1. John D. Winter.  
Principles of Igneous and Metamorphic Petrology 2nd Edition, 2016
2. Robin Gill.  
Igneous Rocks and Processes: A Practical Guide 1st Edition, 2015