NATIONAL UNIVERSITY OF ENGINEERING

COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING

GEOLOGICAL ENGINEERING PROGRAM

GE733 – NON-METALLIC MINERAL DEPOSITS

I. GENERAL INFORMATION

CODE	**:**	GE733 Non-Metallic Mineral Deposits
SEMESTER	**:**	9
CREDITS	**:**	3
HOURS PER WEEK	**:**	5 (Theory–Practice–Field)
PREREQUISITES	**:**	GE701 Mineral Deposits
CONDITION	**:**	Elective
DEPARTMENT	**:**	Geological Engineering

II. COURSE DESCRIPTION

The course points to prepare students to achieve a business vision and a full comprehension of the concepts, seen from both global and specific outlooks, referred to the identification and geological characterization of the different types of industrial rocks and minerals, and others that make up the non-metallic ore; as well as to know the economic importance that involves costs, environment and social impact during the stages of recognition, prospecting, exploration, preparation, development and production of a mining project, until its termination and closure.

The geological concepts are universal but, it is necessary to keep a comparative emphasis when talking about Peruvian ore deposits and from other countries, with a theoretical-practical development.

III. COURSE OUTCOMES

At the end of the course, students:

1. Organize and classify industrial rocks and non-metallic minerals according to their origin, distribution and economic, social and environmental impact.
2. Explain the functions of chemical elements and compounds related to non-metallic ore deposits of industrial interest.
3. Understand the physical and chemical processes that occur both on the surface and inside the land crust, leading to the formation and concentration of non-metallic ore deposits.
4. Interpret the origin of different types of non-metallic minerals stressing their industrial application.
5. Build genesis models for the most important non-metallic deposits, using the acquired experience during the laboratory research.
6. Recognize the most important types of ore deposits, stressing those of industrial interest.

IV. LEARNING UNITS

1. INTRODUCTION

Origin of non-metallic minerals: sedimentary, hydrothermal and mechanical deposits. / Genesis relationship of non-metallic ore with metal ore deposits / Profitability of non-metallic deposits in relation to metal deposits / Forward-looking possibilities, exploratory and exploitation of Peruvian non-metallic deposits, in small, medium and great mining / Prospects of non-metallic mining versus metal mining in the present millennium.

2. PHOSPHATES

Phosphorus geochemical circuits. / Magmatic origin. Association with alkaline rocks and deposits of magmatic segregation. Deposits of Khibine and Kirune / Maritime. Deposits of Phosphoria, Karatau, Bayobar, and Aramachay / Waste. Florida / Biological. Guano deposits / Lithology related to these deposit / Geographical distribution and orogenic relationship at regional and global levels / Prospecting, exploration, exploitation and metallurgy / Geo-economic importance / Phosphates of

Bayobar and others deposits in Peru and the world. Prospecting, exploration, exploitation and metallurgy. Uses of phosphates and their derivatives / Marketing, internal and external markets.

3. DIATOMITES

Sources. Maritime: Ocucaje and Bayobar deposits / Lake: Deposits of the Solitary, Tarucani and Quicapata. / Lithology related to these deposits / Paleogeographic distribution and orogenic relationships at regional and global levels / Geo-economic possibilities of the Peruvian diatomite in the world context. Prospecting, exploration, exploitation and metallurgy / Specifications in the use of diatomites / Marketing, internal and external markets.

4. CLAYS

Sources. Sedimentary, hydrothermal, volcanic and residual (bauxites) / Lithology related to these sites. / Classification according to its composition, properties and industrial use. Common and refractory clay: kaolin, bentonite, pirofilite, others / Paleogeographic distribution and orogenic relationship at regional and global levels / Major fields of Peruvian clay. Geo-economic importance and its relationship with deposits at regional and global level / Prospecting, exploration, exploitation and metallurgy / Tests for the determination of clays. / Specifications for its use. / Marketing, internal and external markets.

5. POZZOLANAS

Natural and artificial pozzolanas. Geological formations related to these deposits / Paleogeographic distribution and orogenic relationship at regional and global levels. / Prospecting, exploration, exploitation and metallurgy / Features and applications / Marketing, internal and external markets.

6. TALC

Soapstone, Sillimanite, Andalusite / Origin and characteristics of these deposits / Presence of these minerals in the deposit of Skarn. / Paleogeography distribution of deposits and the orogenic relationship in the Peru and the world / Importance of these deposits in Peru / Prospecting, exploration, exploitation and metallurgy / Uses of these minerals / Marketing, internal and external markets.

7. COAL

Origin. Macerals, Microlitotypes, lithotypes. / Autochthonous and allochthonous deposits. Humic and sapropelic coal, paralic and limnic. / Lithology related to these sites. / Processes of coalification: peat, lignite, coal, anthracite, graphite. / Paleogeography distribution and orogenic relationship at regional and global levels / Basins of Europe and North America / Peruvian coal deposits: basin and geological formations, cyclotems and tectonics of coals / Reserves, potential, its geo-economic importance at regional and global levels / Prospecting, exploration, exploitation and metallurgy / Liquefaction, gasification and distillation of carbons / Coking, coal briquettes / Applications of carbon and its derivatives / Relationship with asphaltites. / Marketing, internal and external markets.

8. PRECIOUS AND SEMI-PRECIOUS ROCKS. ORNAMENTAL ROCKS

Diamonds in kimberlites, rubellite, proustites, emerald, amazonite, ruby, agate, garnets, turquoise, quartz, tourmaline and others non-metallic minerals / Marbles, alabaster, serpentinite / Onyx, calcareous, geo-interest in Peru and the world. / Paleogeography distribution at local and regional levels, and orogenic relationships / Prospecting, exploration, exploitation and metallurgy / Various uses / Marketing, internal and external markets.

9. CALCAREOUS ROCKS

Limestone, marl, dolomite, travertine, marble, crete, coquina / Geological formations / Paleographic distribution and orogenic relationship at regional and global levels./ Prospecting, exploration, exploitation and metallurgy / Specifications for its different uses. / Marketing, internal and external markets.

10. SULPHUR

Geochemical circuit / Origin. Volcanic, sedimentary, infiltration / Metal deposits related with the production of sulphur and derivatives / Paleogeography distribution of deposits and their orogenic relationship at regional and global levels / Prospecting, exploration, exploitation and metallurgy / Features and uses / Marketing, internal and external markets.

11. PHYLLOSILICATES

Sandy and siliceous rock, quartz, opal, tridymite, cristobalite / Mechanical sands, sandstones, quartzites / Geologic formations related to these minerals / Paleogeography distribution of deposits and its orogenic relationship at regional and global levels / Prospecting, exploration, exploitation and metallurgy / Features and applications / Marketing, internal and external markets / Volcanic glass / Pumite, perlite, obsidian.

12. SALTS

Origin and deposition order / Salts: marine, continental, domes saline, sheds salty, hydrothermal / Salted lakes related to volcanic activity / Classes: chlorides: halite, sylvite, carnallite / Sulfates: polyhalite, ternardite, epsomite, anhydrite, gypsum, glauberite, cainite, alunite, jarosite / Carbonates: sosa, highchair, magnesite, coquita, caliche / Borates: ulexite, kaliborite / Nitrates: Salitres / Paleogeography distribution of deposits and their orogenic relationship in the Peru and the world / Description of main deposits in Peruvian and the world / Prospecting, exploration, exploitation and metallurgy / Uses of salts and their derivatives / Marketing, internal and external markets.

13. FLUORITE

Geochemical circuit / Origin: hydrothermal, sedimentary / Paleogeography distribution of deposits and orogenic relationship in the Peru and the world / Prospecting, exploration, exploitation and metallurgy / Applications of barium in different industries / Marketing, internal and external markets. Iodine, bromine, strontium, argon, chromite, emery, others / Fluorite. Geochemical circuit / Origin. hydrothermal, sedimentary biochemical / Paleogeography distribution of deposits of fluorite in Peru / Prospecting, exploration, exploitation and metallurgy / Specifications for its different uses / Marketing, internal and external markets / Asbestos / Chrysotile in serpentine and asbestos in amphiboles / Pegmatite: feldspars, micas, silicates, sluminic, silicates aluminic with beryllium ochre / Origin: primary, residual / Natural and synthetic pigments / Main occurrences in Peru and the world / Prospecting, exploration, exploitation and metallurgy / Uses of these minerals / Marketing, internal and external markets

14. INDUSTRIAL MATERIALS

Construction and industry materials / Non-consolidated deposits / Igneous, sedimentary, and metamorphic rocks, bricks, cement, manufacturing of rock, clay and other minerals / Rare earth / Industrial mining.

V. LABORATORY

The practical experience is obtained:

a) In cabinet, from the direct study of a great number of samples with non-metallic mineralization. Macroscopic observation and with magnifiers. Recognizing the type of minerals and percentage content for each sample.
b) In field, from the direct observation of the lithological context, structural and mineralogical characteristics of the site.

VI. METHODOLOGY

The course includes theoretical themes exposed by faculty and simultaneously analyzed and discussed with geological criteria by students. Each advanced theme is investigated in depth by 3 students in the class and exposed in great detail in the following class for half hour, and additional half-hour discussion with questions asked by 6 students. Each topic researched in depth through literature and exposition by each group of 3 students.

VII. GRADING FORMULA

The Final Grade PF is calculated as follow:

$$PF = (EP + EF + PP)/3 + FP*(20 – NA) / n$$

EP: Partial exam
EF: Final exam
PP: Average of quizzes
FP: Bonus dependis on assistance and participation in class

VIII. BIBLIOGRAPHY

1. Smirnov, V.I.
   Geology of Ore Deposits Ed. Mir, Moscow, 2012.
2. Díaz, A, & Ramírez, J.
   Compendium of Rocks and Minerals in the Peruvian Industry, INGEMMET, 2009.
3. Dunin Borkowski, E,
   Industrial Minerals of Peru. INGEMMET, 2015.