UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Geochemistry

2324-2-E3401Q017

Aims

The course introduces to the fundamental principles of Geochemistry and aims to explain the chemical mechanisms and principles underlying the main geological processes, and the interconnections with the other disciplines of Earth Sciences. Students acquire the knowledge to characterize and classify the origin of elements and isotopes, and their distribution in the main geochemical reservoirs and geospheres. The course allows understanding and interpreting the processes of chemical and isotopic fractionation processes, and the use of elements and isotopic ratios as tracers of geological, hydrogeological, petrogenetic, and volcanological processes. Knowledge of some radionuclides' decay processes, their implications on geochronology, and the main dating methods used will be imparted. Students are able to reconstruct the geochemical cycles of the elements in different environments and geospheres. A nod will be given to analytical methodologies and techniques in the laboratory, with visits to the available analytical laboratories; in addition, an overview of fluid and rock sampling techniques will be provided, where possible with a field trip. Finally, basic knowledge of geochemical data visualization and processing methods will be imparted.
The course provides basic quantitative and modelling knowledge for subsequent applications to natural and industrial processes.

Contents

Basic notions of Geochemistry. Fundamentals of nucleosynthesis and cosmochemistry. Evolution of the Earth. Geochemical affinity of the elements. Geochemical spheres. Geochemistry of the atmosphere. Geochemistry of magmatic volatiles. Volatile solubility. Magmatic degassing. Geochemistry of the Hydrosphere. Mechanical and chemical weathering. Geochemistry of the lithosphere. Geochemical cycles. Geochemistry of stable isotopes. Radioactive decay, basics of Geochronology. Geochemistry of radiogenic isotopes. Geochemistry of noble gases. Main water, gas and rock sampling methodologies and analytical techniques. Methods of visualization and processing of geochemical data. Notes on the applications of Geochemistry.

Detailed program

Presentation of the course. Basic notions of Geochemistry. Geochemical spheres. Review the elements' main properties in relation to their position in the periodic table. The internal structure of atoms.
Fundamentals of nucleosynthesis and cosmochemistry. Evolution of the Earth.
Geochemical affinity of the elements, their influence on geochemical behaviour. Geochemical spheres.
Geochemistry of the atmosphere: genesis, evolution and chemical-physical properties, current composition and structure.
Geochemistry of magmatic volatiles. Classification of magmatic, volcanic and hydrothermal gases. Solubility of volatiles in silicate melts. Magmatic degassing. Sampling techniques and analysis of volcanic gases.
Geochemistry of the hydrosphere, geochemistry of waters. Chemical equilibria in the aqueous phase. Partition coefficients. Weathering processes. Oxidation-reduction reactions. Eh-pH diagrams. Water sampling techniques and measurement of chemical-physical parameters.
Geochemistry of the lithosphere. Chemical composition of the solid Earth: Core, Mantle and Crust. Element classification. Major and trace elements. Classification diagrams. Partition coefficients.
Geochemistry of stable isotopes (H, O, C, N, S). Delta notation, fractionation and enrichment factor. International standards. Isotopic fractionations. Evaporation and condensation process: the example of oceans and rains. Isotope composition of precipitation, world meteoric line.
Basics of geochronology. Mechanisms of radioactive decay, general equation of radioactive decay. Main geochronological methods.
Geochemistry of radiogenic isotopes as petrogenetic tracers.
Geochemistry of noble gases. Partition coefficients. Classification in the main geochemical reservoirs and geospheres.
Notes on the applications of Geochemistry.
Methods of visualization and processing of geochemical data.

Prerequisites

Chemistry

Teaching form

Lectures (7 CFU)
Laboratory (0.5 CFU)
Exercise (0.5 CFU)

Textbook and teaching resource

Slides provided during the lessons

BOOKS
W.M. White, Geochemistry
McSween H.Y., Richardson S.M. Jr., Uhle M.E., Geochemistry (Pathways and Processes)
Walker M., Quaternary Dating Methods, Wiley
A. Longinelli, S. Deganello, Introduzione alla Geochimica
Ozima M. & Podosek F.A. (2002), Noble Gas Geochemistry, Cambridge University

Burnard P., The Noble Gases as geochemical tracers, Springer
Dongarrà G. & Varrica D. (2004) “Geochimica e ambiente” EDISES
Faure G. (1998), Principles and Applications of Geochemistry
Krauskopf K.B. & Bird, D. K., Introduction to Geochemistry, 1995. McGraw-Hill International Editions.
J. Hoefs, Stable isotope Geochemistry
C.J. Allègre, Isotope Geology

Semester

II semester

Assessment method

Oral exam consisting of an interview on the topics developed during the course. The exam consists of at least three open questions, the first of which is a topic of the program chosen by the student. The teacher will evaluate the knowledge and deepening of the concepts, the ability to connect the topics, the expository clarity, the use of a language appropriate to the subject, and the commitment made to prepare for the exam.

Vote out of thirty

Office hours

To make an appointment, please write to andrealuca.rizzo@unimib.it

Sustainable Development Goals