UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Geochronology and Geochemistry of The Solid Earth

2425-1-F7401Q122

Aims

The course delves into the main methods of absolute and relative dating on a long and short time scale, and the related analytical study techniques. Students acquire knowledge of the radioactive decay of the most used radionuclides and the main radiometric methods of absolute dating; non-radiometric methods of relative dating will also be explored in depth.
Furthermore, the course applies the fundamental principles of fluid geochemistry to reconstruct the origin and cycle of volatiles in the Earth's interior ultimately released into the atmosphere/hydrosphere by volcanism. Students, with a multidisciplinary approach, learn to use the geochemical tracers of fluids (particularly isotopic ones), placing them in relation to terrestrial geodynamics, magmatic/volcanic degassing in underwater and subaerial environments, and the impact on the terrestrial climate.
Finally, the course provides practical skills on techniques for sampling fluids and/or rocks from the ground, on the main analytical methodologies in the laboratory and in the field, methods of acquisition, visualization and processing of geochemical data.

Contents

Recall of nucleosynthesis, origin and evolution of the Earth, atomic structure and definition of unstable isotope. Concept of radioactive decay, decay mechanisms, radiometric methods of absolute dating on long and short time scales. Dating through cosmogenic nuclides. Non-radiometric dating methods. Radiogenic isotopes.
Basic concepts of fluid geochemistry. Stable isotopes and isotopes of noble gases. Composition of volatiles in mantle, magma and volcanic/hydrothermal systems. Solubility of volatiles in silicate melts. Magmatic degassing. Compositional variations in relation to geodynamics. Impact of degassing on marine/ocean and atmospheric ecosystems, climate implications. Cycle of volatiles in the mantle.
Main fluid/rock sampling techniques, practical field experience, and analytical methodologies. Acquisition, visualization and processing of geochemical data.

Detailed program

Presentation of the course. Recall on atomic structure, definition of stable, unstable and radiogenic isotope. Notes on nucleosynthesis, formation and evolution of the Earth, geochemical affinity of the elements, geochemical spheres. Recalls on major and trace elements.
Concept of radioactive decay, main decay mechanisms, general equation of radioactive decay. Rb-Sr, Sm-Nd, U-Th-Pb, K-Ar and ³?Ar-??Ar method. Dating through radiocarbon (¹?C) and other cosmogenic nuclides (e.g. ³He, ³H). Non-radiometric dating methods based on the regular accumulation of sediments, ice or biological material (e.g. varve dating and dendrochronology) over time, and relative dating based on age equivalence. Recall on stable isotopes, radiogenic isotopes and isotopes of noble gases. Stable isotopes (delta¹³C, delta¹?O, deltaD) as geochronometers and paleoclimatic reconstruction methods.
Composition of mantle/magmatic/volcanic volatiles (H?O, CO?, S, noble gases, halogens) and compositional variations in relation to geodynamics. Solubility of volatiles in silicate melts and distribution of species among the coexisting phases. Magmatic degassing: definition, typology and main models used. Processes of fractionation, contamination and mixing between gases of different origins. Volcanism and degassing in underwater environments; impact on marine/ocean and atmospheric ecosystems, climate change. General implications on the volatile cycle in relation to geodynamics.
Principles of mass spectrometry. Methods of acquisition, visualization and processing of geochemical data. Visit to the DISAT noble gas laboratory.
Excursion to verify in the field the concepts acquired during the course, practical experience of sampling fluids/rocks for subsequent geochemical analyzes and field measurements (possible targets Canary Islands, Aeolian Islands, Etna, Flegrei-Vesuvius).

Prerequisites

Students must have taken the Safety course to attend field work.
The “Introduction to Volcanology” course foreseen as an elective subject in the three-year course is recommended.

Teaching form

Total hours: 52
14 two-hour lectures, in person, Delivered Didactics
4 six-hour field activities, in person, Interactive Teaching

Textbook and teaching resource

Slides provided during the lessons, scientific publications
BOOKS
Walker M., Quaternary Dating Methods, Wiley
W.M. White, Geochemistry
McSween H.Y., Richardson S.M. Jr., Uhle M.E., Geochemistry (Pathways and Processes)
J. Hoefs, Stable isotope Geochemistry
Porcelli, D., Ballentine, C.J. and Wieler, R. (2002). An introduction to noble gas geochemistry and cosmochemistry. Reviews in Mineralogy and Geochemistry, 47: 1-18.
FURTHER INSIGHTS

A. Longinelli, S. Deganello, Introduzione alla Geochimica
Faure G. (1998), Principles and Applications of Geochemistry
Krauskopf K.B. & Bird, D. K., Introduction to Geochemistry, 1995. McGraw-Hill International Editions.
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
C.J. Allègre, Isotope Geology

Semester

First semester

Assessment method

Students will be assessed on an oral test on the topics covered during the course (70% of the grade) and a report/presentation relating to the excursion (30% of the grade). The oral exam is made up of no fewer than three open questions, the first of which is a topic of the program chosen by the student. The teacher will evaluate the knowledge and depth of the concepts, the ability to connect the topics, the clarity of presentation, the use of language appropriate to the subject, the commitment made in preparing for the exam, the attendance of the course.

Vote out of thirty

Office hours

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

Sustainable Development Goals