TITOLO DEL CORSO ISOTOPE GEOCHEMISTRY AND ITS APPLICATIONS			
Settore Scientifico - Disciplinare: **GEO/08**		**CFU: 6** (5 LF + 1 LAB)	**Ore: 52**
Ore di studio per attività:	**Lezioni frontali:** 2	**Laboratorio:** 1	**Attività di campo:** 0
Tipologia di attività formativa: caratterizzante			

SYLLABUS

Prerequisiti: Geochemistry, Chemistry, Physics, Mathematics, Mineralogy, Petrography, English.

Lezioni frontali	
numero di ore 4	Argomento: *Safety regulations for laboratory workers*. *Sampling and sample preparation techniques:* sampling of rocks, waters and gases. Sample preparation laboratory techniques aimed at elemental and isotopic analyses.
numero di ore 6	Argomento: *Elemental analytical techniques:* spectrometric techniques (atomic absorption spectrophotometry; X-rays fluorescence spectrometry; inductively coupled plasma spectrometry (optical emission spectrometry and mass spectrometry). *Isotopic analytical techniques:* principles of mass spectrometry: Nier-type mass spectrometers, mono- and multi-collector systems, fore vacuum and high vacuum systems. Alfa- and gamma-spectrometry techniques; radioactivity detectors. *Microanalysis techniques:* electron microprobe, EDS and WDS systems, ion and proton microprobes, SHRIMP, laser ablation systems.
numero di ore 6	Argomento: *Radiogenic isotope geochemistry:* definitions, chart of nuclides, isotopic abundances, radioactive decay and growth, radioactive decay general low, radioactive decay constants, half-life, radioactive decay mechanisms; absolute geochronology: isochron method; Rb-Sr systematics, Sm-Nd systematics, ^{14}C method; K-Ar and Ar-Ar systematics; radioactive decay series, U-Th-Pb systematics, concordia-discordia diagram; other isotopic systematics (Lu-Hf, Re-Os).
numero di ore 4	Argomento: *Stable isotope geochemistry:* definitions, delta notation, equilibrium and kinetic fractionations, mass-dependent and mass-independent fractionations; isotopic geothermometry. *Mixing and dilution*: definitions, mixing equations, two- and three-components mixtures, isotopic mixtures.
numero di ore 4	Argomento: *Applications of isotope geochemistry to geochronology:* dating of metamorphic events through Rb-Sr and Ar-Ar; dating of meteorites, age of the Earth; common Pb and dating of sulfide ores; isotopic evolution of Sr and Nd through time.
numero di ore 4	Argomento: *Applications of isotope geochemistry to petrology:* isotopic variations in MORB, OIB, oceanic and continental subduction zone magmas, CFB and LIP; mantle sources of basalts; closed- and open-system magma differentiation processes, AFC processes;

	effects of marine and hydrothermal waters alteration; O, H and C isotopes in mantle and basalts; genesis of granites; isotopic chemostratigraphy.
numero di ore 2	Argomento: *Applications of isotope geochemistry to ore deposits geology, palaeoclimatology, hydrology and biology*.
numero di ore 3	Argomento: *Applications of isotope geochemistry to radioactive waste management:* uranium fuel cycle; types of nuclear waste; geological sites for nuclear waste disposal; environmental radioactivity.
numero di ore 5	Argomento: *Applications of isotope geochemistry to heavy metal pollution management:* isotope geochemistry of Pb: common Pb sources, tetraethil Pb, pollution of soils, plants, food, effects of Pb on life; isotope geochemistry of Cr: tetravalent and hexavalent Cr, Cr speciation, pollution of soils, plants, food, effects of Cr on life; isotope geochemistry of Cd: Cd speciation, influence of redox state on Cr isotopic composition, pollution of soils, plants, food, effects of Cd on life.
numero di ore 2	Argomento: *Applications of stable isotope geochemistry to the atmosphere:* trace gases, greenhouse gases, budgets of trace gases; variations through time.
Laboratorio	
numero di ore 2	Attività: *Rock sample preparation laboratory techniques aimed at elemental and isotopic analyses:* dissolution techniques through mineral acids attack: using HF, HNO_3, HCl, devices and laboratories specific for isotopic analysis (clean rooms, suprapur and ultrapure reagents, Teflon vessels and bottles).
numero di ore 4	Attività: *Practice on elemental analytical techniques:* atomic absorption spectrophotometry: setting up of calibration lines, standards, detection limits; X-rays fluorescence spectrometry: setting up of calibration lines, standards, detection limits; inductively coupled plasma spectrometry: setting up of calibration lines, standards, detection limits.
numero di ore 6	Attività: *Practice on isotopic analytical techniques:* thermal ionization mass spectrometers: solid source spectrometers, magnetic field-mass calibration curve; sample loading on the filament; sample heating, signal search and focusing, mass spectra, mass shape, data acquisition; international reference standards; in-run fractionation correction, mass interferences correction; gas source spectrometers: sample introduction systems, dual-inlet system, continuous flow system.
Risultati di apprendimento attesi	
Knowledge and understanding The students must demonstrate knowledge and understanding of the principles of both radiogenic and stable isotope geochemistry. The newly acquired knowledge must enhance the previously acquired knowledge in geochemistry and other geosciences, providing a basis for originality in developing and/or applying those principles to Earth Sciences problems, within future employment activities concerning either geological, environmental or scientific research issues.	
Applying knowledge and understanding The students must be able to apply their knowledge and understanding of the principles of both	

radiogenic and stable isotope geochemistry, and demonstrate problem solving abilities in new or unfamiliar environments, facing geological, environmental or scientific research problems within broader contexts related to their field of study. During the course the students will be given the opportunity to apply some of the theoretical knowledge to practical activities in the laboratory.
Making judgements The students must have the ability to integrate the newly acquired knowledge of both radiogenic and stable isotope geochemistry with previously acquired knowledge on geosciences, in order to handle complex problems, and formulate judgments with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgments.
Abilità comunicative The students must be able to communicate their conclusions on the application of the principles of radiogenic and stable isotope geochemistry, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences clearly and unambiguously. The students must demonstrate this ability through presentation of a report (for example, a PowerPoint presentation) at the final exam, that should, through the rights technical language and tools, illustrate a problem and its solution by means of the isotope geochemistry methods.
Learning skills The students must have the learning skills to allow them to continue to study isotope geochemistry issues in a manner that may be largely self-directed or autonomous. During the course the students will be given the main tools that will allow them to learn new methods and acquire further information on geological, environmental or scientific research problems to be solved by means of the isotope geochemistry methods.
Modalità di verifica dell'apprendimento
Esame finale: The final exam will consist of an oral discussion concerning the arguments of the Course, supported by a PowerPoint presentation set up by the student on a chosen topic.