



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DST

DIPARTIMENTO DI
SCIENZE DELLA TERRA

ECCELLENZA 2023-2027

Da un secolo, oltre.

**PHD COURSE ON
EARTH AND PLANETARY SCIENCES
aa 2024-2025**

AVANZINELLI RICCARDO (riccardo.avanzinelli@unifi.it)

Measurements of isotope ratios through TIMS and MC-ICPMS and applications to Geosciences (6h, 1 CFU)

Date: 2nd half of June 2025

The aim of the course is to provide the basics knowledge of the analytical procedures for the measurements of isotope ratios via Multicollector Thermal (TIMS) and Plasma-sourced (MC-ICPMS) Mass Spectrometer. The course consists of 1 lessons (3 hours) and a laboratory experience (3 hours) at the Radiogenic Isotope Geochemistry Laboratory of the Università degli Studi di Firenze.

Lesson 1 (3 hours): brief introduction to isotopes; chemical methods for sample purification through cation exchange chromatography; description of TIMS and MCICPM Sand differences. Corrections and key issues related to the measurements of isotope ratios (e.g. Mass Bias and its correction). Static vs. Multidynamic measurements. Isotope Dilution measurements. Description of the complete analytical procedure for selected isotopic systematics (e.g. Sr, Pb, U-Th).

Lab experience (3 hours): Visit to the Radiogenic Isotope Geochemistry Laboratory of the Università degli Studi di Firenze with practical experience of operating a TIMS instrument for the measurements of isotopic ratios.



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BELVEDERE MATTEO (matteo.belvedere@unifi.it)

Close-range photogrammetry paleontology and museum heritage. From pictures to 3D models basics (12h, 2 CFU)

Date: 27 and 28 January 2025

3D data production and visualization have become an integral part of archaeological, paleontological studies and is increasing its importance in museum heritage conservation.

Close-range photogrammetry (surface 3D digitizing from digital photographs) is one of the most used, relatively cheap, and versatile method used for surface digitization. This course will teach the basics of photogrammetry for paleontology and museum heritage.

Lesson 1: theoretical basic knowledge of Structure-from-Motion photogrammetry and how to take pictures

Lesson 2: workflow and comparison of the most commonly used software.

Lessons 3-4: practical lessons with samples brought by participants.

Participant number is limited to 10-15 (depending on next year's distancing rules); the course is primarily addressed to doctoral and master students; other participants are also welcome, although priority will be given to the previous categories. On the base of the nationality of participants, the course will be held in Italian or English.

MARCO BENVENUTI (m.benvenuti@unifi.it)

Dai giacimenti ai metalli: una storia lunga millenni (6h, 1 CFU)

From deposits to metals: a thousand-year history (6h, 1 CFU)

Date: da definire col docente - to be defined with lecturer

La distribuzione ed abbondanza naturale dei metalli. Concetto di "minerale metallifero". Fattori di controllo per lo sfruttamento dei minerali metalliferi in epoca antica: disponibilità geologica e tecnologica. Il processo metallurgico: aspetti generali. Le scorie metallurgiche. Combustibili, fondenti, sorgenti di energia per il processo metallurgico. Tipi di reattori (crogiuoli, forni). Cenni sull'evoluzione storica della metallurgia in epoca pre-Industriale, con particolare riferimento alla produzione di rame/bronzo e ferro/acciaio.



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Uso di elementi in tracce e isotopi (del piombo) per studi di provenienza e/o tecnologie di produzione di manufatti metallurgici antichi.

COMPETENZE ACQUISITE: visione diacronica dello sviluppo delle conoscenze sullo sfruttamento dei metalli da parte delle società pre-moderne.

EROGAZIONE: preferibilmente in presenza (in aula), a meno di richiesta diversa da parte degli interessati.

Distribution and Natural Abundance of Metals. The concept of "metalliferous minerals". Factors Influencing the Exploitation of Metalliferous Minerals in Ancient Times: Geological availability and Technological constraints

The Metallurgical Process: General Aspects: Metallurgical slags. Fuels, fluxes, and energy sources for metallurgical processes. Types of reactors (crucibles, furnaces).

Historical Evolution of Pre-Industrial Metallurgy. Focus on copper/bronze and iron/steel production.

Trace Elements and (Lead) Isotopes in Archaeometallurgy. Applications in provenance studies. Insights into ancient metal production technologies.

ACQUIRED SKILLS

A diachronic perspective on the development of metal exploitation knowledge in pre-modern societies.

TEACHING DELIVERY METHODS

Preferably in-person (classroom-based), unless otherwise requested by participants.



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BIANCHINI SILVIA (silvia.bianchini@unifi.it)

Tecniche di detection and mapping da dati radar interferometrici satellitari applicate all'instabilità del terreno e dei manufatti (6h, 1 CFU)

Date: giugno – luglio 2025

Il corso consiste in lezioni frontali ed esercitazioni pratiche (su software ArcGIS pro) e si pone l'obiettivo di fornire conoscenze sui seguenti argomenti: cenni teorici di base di interferometria radar satellitare differenziale e multi-temporale PSI (Persistent Scatterers Interferometry); procedure e tecniche radar-interpretazione di dati radar interferometrici satellitari PSI per l'identificazione, mappatura e caratterizzazione di spostamenti del terreno a scala regionale e a scala locale.

COSTAGLIOLA PILARIO (pilario.costagliola@unifi.it)

Elementi di giacimenti minerali (6h, 1 CFU)

Date: to be defined with the students

Il corso di elementi di giacimenti minerali per i dottorandi di Unifi intende fornire alcuni elementi base di geologia economica per capire come e quanto la coltivazione mineraria possa e potrà influire sulle nostre vite senza entrare eccessivamente in dettagli strettamente geologici.

Il corso si articolerà su argomenti come la storia ed il peso della coltivazione mineraria, la pressione sociale che potenzialmente esercita, la ricchezza che è in grado di produrre e le conseguenze ambientali. Questi argomenti saranno trattati nell'ottica della transizione energetica che stiamo vivendo. Qualche slide sarà, infine, dedicata alle terre rare dell'Ucraina in considerazione dell'attualità del tema.

E' potenzialmente aperto anche ad altri studenti, oltre i dottorandi, al personale UNIFI e altre persone interessate a questi argomenti. Non è prevista una fase di campagna ma, nel caso gli studenti fossero interessati, è possibile organizzare visite a giacimenti toscani dismessi.

DELLA SCHIAVA ELENA (elenadellaschiava@libero.it)

Investigations on cultural heritage during restoration: the casting cores ("terre di fusione") of some sculptures bronze by Donatello and other authors of the Florentine Renaissance (6h, 1 CFU)



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Date: February - March, 2025 (18 - 19 march 2025 - 9.30/12.30 to be confirmed, web seminary)

- Introduction (explanation of the works carried out, photos, examples of some investigations on various works, objectives achieved);
 - Casting cores; casting techniques (photos, examples, earth samples, works, creation of a sculpture);
 - Analytical techniques for characterizing casting cores;
 - The state of the art on casting cores (restoration and scientific articles, bibliographies and literature);
 - Technological considerations (the contribution to the technological investigations of the bronze sculptures):
 - Conservation problems of the earth in situ in statues (emptying, metal/core interface phenomena);
 - How to sample casting cores to optimize analytical results;
 - Casting cores samples;
 - The casting cores of San Giovanni Battista (1571) by Vincenzo Danti (sampling, investigations, objectives, results);
 - The casting cores of some Donatello sculptures created between the 1920s and 1960s
- 15th century (sampling, investigations, objectives, results);
- Conclusions.



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GAMBACORTA GABRIELE (gabriele.gambacorta@unifi.it)

Origin and fate of organic matter from land to oceans (12h, 2 CFU)

Date: 8 e 9 September 2025 (to be confirmed)

The course is aimed to provide participants with basic knowledge about fine-grained sediments and black shale, characteristics, transport and deposition. The course consists of frontal lessons and exercises that will allow the participants to better understand what explained during the class.

Lesson 1 (6 h):

- Introduction to organic facies and black shales; processes responsible for mudrocks and black shale erosion, transport and deposition; physical and chemical properties of mudrocks and source rocks; mudrocks and source rocks lateral and vertical heterogeneity from thin-section-, core-, log-, to seismic-scale.
- Organic matter production: type, amount, variation from proximal to distal settings, water column processes.
- Preservation processes: organic-matter degradation along the water column and at the sediment-water interface, organic carbon accumulation rate, burial efficiency, preservation factor.

Lesson 2 (6 h):

- Organic matter dilution: sediment supply, distribution of organic matter in the different depositional environments, detrital sedimentation rate impact on dilution and preservation of organic matter; principles of source rock sequence stratigraphy.
- Modern and ancient source rock depositional environments from marine to continental settings.
- Fine-grained sediments and black shales burial and diagenesis. An overview on present and future applications.



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GOZZI CATERINA (caterina.gozzi@unifi.it)

1) Introduction & Basics of R (6h, 1 CFU)

Date: June 2025 - to be defined with the students

R is both a programming language and an interactive environment for statistics with an extensive catalog of statistical and graphical methods. Its flexibility, power, sophistication, have made it an invaluable tool for scientists around the world. The aim of the course is to provide the basic knowledge needed to start using the R software. The course is organized in 2 lessons of 3 hours each, as follows:

Lesson 1 - Introduction to R

In this lesson, participants will learn how to install R and RStudio and how to begin using RStudio effectively. The lesson will provide an overview of the main components and features of the interface, including how to execute commands, use operators and functions, and access the help window for documentation and support in R.

Lesson 2 - R applications to Earth Sciences:

In this lesson, participants will learn how to import data into R, the fundamentals of research statistics, exploratory data analysis, and how to create various types of plots (e.g., histograms, boxplots and correlation matrices). Practical exercises will also be carried out in R with a geochemical dataset.

2) Writing a PhD Thesis in LaTeX (6h, 1 CFU)

Date: May 2025 - to be defined with the students

LaTeX is a powerful document preparation system for high-quality typesetting. It is most often used for medium-to-large technical or scientific documents but it can be used for almost any form of publishing. It was created by scientists for scientists, and it has a large and active community of users. The aim of the course is to provide the basic knowledge needed to start typesetting a PhD thesis using LaTeX.

The course is organized in 2 lessons of 3 hours each, as follows:

Lesson 1 - Introduction to LaTeX:

This lesson introduces the advantages of using LaTeX for document preparation. Participants will learn how to typeset text, choose font types, work with LaTeX environments, and use packages and templates to enhance document formatting.

Lesson 2 - How to Write the Thesis in LaTeX:



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In this lesson, participants will learn how to structure a thesis, create sections, manage cross-references, format tables and figures, and generate a bibliography using BibDesk. Practical exercises will also be carried out in LaTeX using the “classicthesis” template.

LEPORE GIOVANNI ORAZIO (giovanniorazio.lepore@unifi.it)

Practical introduction to X-ray absorption spectroscopy (XAS) with applications to mineralogical and environmental sciences - Introduzione pratica alla spettroscopia di assorbimento di raggi X (XAS) con applicazioni alla mineralogia e all'ambiente (12h, 2 CFU)

Date: to be defined with the students

- Introduzione alle sorgenti di luce di sincrotrone.
- Introduzione teorica alla spettroscopia di assorbimento di raggi X (XAS).
- Tutorial pratico sull'analisi di dati XAS.
- Applicazioni alla mineralogia e alle scienze ambientali.

Il corso prevede lezioni frontali ed esercitazioni.

- Introduction to synchrotron light sources.
- Introduction to X-ray Absorption Spectroscopy (XAS).
- Practical tutorial on XAS data analysis.
- Applications to mineralogical and environmental sciences.

Class lectures and exercises.



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MAESTRELLI DANIELE (daniele.maestrelli@igg.cnr.it)

Analogue modelling of volcano-tectonic processes: from nature to lab (12h, 2 CFU)

Date: 2 days, in the week 30 June- 4 July.

The aim of the course is to provide PhD students with an introduction to the study of volcano-tectonic processes in various tectonic contexts, from local- to regional-scale, through the use of advanced analogue modelling techniques and dedicated analyses.

Main topics:

- Introduction to analogue modelling techniques applied to the study of volcano-tectonic processes.
- The volcano-tectonic processes and magma-related deformations seen through analogue models: case studies and practical implications. From magma migration to magma emplacement/eruption and associated deformations: magma versus rifting (magma assisted rifting); magma emplacement in compressive and transcurrent settings; the structural control of local- to regional- scale tectonics on the formation and evolution of collapsed calderas and volcanic edifices; volcanic edifices and post collapse calderas deformation, caldera resurgence-associated deformation.
- Practice: modelling volcano-tectonic processes, lab exercises and analyses.

MANCA ROSAROSA (rosarosa.manca@unifi.it)

Applications of X-rays based techniques for the non-invasive characterization of geomaterials in cultural heritage (12h, 2 CFU)

Date: March-June 2025 - to be defined with the participants

The course aims at providing an overview of the possible applications of X-ray Fluorescence (XRF) spectroscopy and Particle-Induced X-ray Emission (PIXE) analysis to the non-invasive characterization of geomaterials, with a specific focus on the field of cultural heritage.

The principles of the two techniques will be presented and compared. The cases of ancient gold jewellery and glazed pottery will be examined. The course includes a visit to the XRF lab of the Earth Sciences Department (Unifi) and to the LABEC, INFN, Sesto Fiorentino.

Part 1: Introduction on Geomaterials and Cultural Heritage. Non-invasive approaches: advantages and limitations. X-rays Fluorescence (XRF) spectroscopy, Particle-Induced



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X-ray Emission (PIXE) and Particle-Induced Gamma Emission (PIGE) analyses: introduction to basic theory.

Part 2: Case studies in the field of Cultural Heritage:

- a) XRF and PIXE analysis of gold jewellery. Quantification and ternary diagrams. Secondary filters for detection of trace elements. Study of compositional gradients from the surface to the subsurface.
- b) XRF and PIXE-PIGE analysis of glazes. The problems of light elements and overlapping X-rays lines. Indirect information on the layer structure.

NATALI CLAUDIO (claudio.natali@unifi.it)

Identificazione di tenori di fondo geogenici e anomalie di origine antropogenica in sistemi ambientali (8h, 1,33 CFU)

Date: to be defined with the students – 2 last weeks of July

Il Corso si articola in 4 lezioni della durata di 2 ore che riguarderanno metodi di indagine per lo studio della variabilità naturale e l'identificazione dei contributi di origine antropogenica in diversi contesti ambientali (suoli, fiumi, lagune costiere). Saranno presentati vari casi di studio in cui si è potuto identificare il legame fra la matrice investigata (acqua, solido sospeso, sedimento di fondo, suolo) e le rocce del bacino di provenienza, gli accumuli preferenziali di alcuni metalli pesanti in relazione a diversi contesti deposizionali ed i contributi di origine antropogenica. Saranno illustrate le potenzialità dell'approccio di studio petrografico-geochimico a tali problematiche, e si affronteranno inoltre aspetti relativi alla vigente normativa ambientale.



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MORANA MARTA (marta.morana@unifi.it)

1) High-pressure experimental techniques - Metodi sperimentali ad alta pressione (15h, 2,5 CFU)

Date: to be defined with the participants

Introduction to high-pressure experimental techniques; piston-cylinder and multianvil techniques; diamond anvil cells techniques; probing techniques based on electromagnetic radiation; pressure and equation of state; dynamic compression; synchrotron and neutron studies in Earth and planetary sciences.

Only class lectures.

Introduzione ai metodi sperimentali ad alta pressione; dispositivi piston-cylinder e multianvil; celle a incudine di diamante; tecniche di caratterizzazione ad alta pressione; pressione ed equazioni di stato; compressione dinamica; applicazioni con neutroni e luce di sincrotrone nelle scienze della Terra e planetarie.

Il corso prevede solo lezioni frontali.

2) Physical aspects of color - Fisica del colore (15h, 2,5 CFU)

Date: to be defined with the participants

Light and color; polarization and crystals: refraction, dichroism, pleochroism; color from atoms and ions: crystal field theory; impurity colors; luminescence.

Only class lectures.

Luce e colore; polarizzazione e cristalli: rifrazione, dicroismo, pleocroismo; colore, atomi e ioni: teoria del campo cristallino; colore e impurezze; luminescenza.

Il corso prevede solo lezioni frontali.

PAZZI VERONICA (veronica.pazzi@unifi.it)

How geophysical techniques can help to deal with different environmental problems (12 ore, 2 CFU)

Date: May-July 2025 (to be defined with the students)

The aim of the course is to provide an overview on how different geophysical techniques can help in understanding different environmental problems (e.g.: soil instabilities, landfills, dam's stability...). After an introduction on the main geophysical techniques (e.g., electrical resistivity tomographies, seismic noise measurements, seismic refraction tomographies, ground penetrating radar), the PhD students will be



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asked to read, understand, and present to the others a scientific paper where the geophysical techniques are employed to characterize and understand a specific environmental problem.

RANERI SIMONA (simona.raneri@unifi.it)

Geosciences for Cultural Heritage: challenges and innovative methods (12h, 2 CFU)

Date: The course consists of three 4-hour lectures, scheduled for March 10, 12, and 14, 2025, from 9:00 AM to 1:00 PM. The course will be delivered online and in English. Please email the professor by February 28th to express your interest in participating.

Geosciences are becoming increasingly relevant to studying cultural heritage, given that many archeological and artistic objects are made of geomaterials. The characterization, provenance, technological issues, but also the preservation and conservation strategies of cultural heritage materials could benefit from the technological advances offered by the approaches and techniques of geosciences. In particular, non-destructive and non-invasive techniques are particularly suitable for characterizing cultural heritage materials, which in most cases cannot be sampled or moved from their original set. In the field of conservation science, nanotechnologies open up new perspectives for the development of new strategies and approaches. Finally, large scale facilities are expanding the possibilities for the study of complex micro-samples that are typically sampled from precious cultural heritage objects. The upstreaming and downstreaming challenges offered by the geosciences for cultural heritages will be discussed, with case studies illustrating how different methodological approaches can answer the most common questions posed by archaeologists, art historians and heritage conservation scientists.

TASSI FRANCO (franco.tassi@unifi.it)

Tecniche strumentali per analisi composizionali ed isotopiche di acque e gas (6h, 1 CFU)

Date: To be defined with the students

Il corso si svolgerà in due lezioni della durata di 3 ore ciascuna ed ha come obiettivo la formazione degli studenti all'utilizzo di strumentazione recentemente acquisita dai



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laboratori di acque e geochimica dei fluidi del DST-UniFi. Nello specifico, verranno trattate tecniche cromatografiche con gli strumenti Erreci S1130 (IC) e Agilent 8860 (GC), spettrofotometria (Agilent Cary 60 UV-vis) e spettroscopia cavity ring-down (Picarro G2201-i, Picarro L2130-i, Picarro Caddy A2100). Alle informazioni di carattere teorico erogate con lezioni frontali, saranno affiancate esercitazioni in laboratorio con utilizzo dei suddetti strumenti.