

**DOTTORATO TOSCANO in SCIENZE DELLA TERRA**  
**(Università degli Studi di Firenze, Pisa e Siena)**  
**DIDATTICA INTERNA aa 2022-2023**

**CORSI PROPOSTI DALLA SEDE DI FIRENZE**

**RICCARDO AVANZINELLI (riccardo.avanzinelli@unifi.it)**

**Measurements of isotope ratios through TIMS and MC-ICPMS and applications to Geosciences (8 ore, 1 CFU)**

**(DATE: 2nd half of June 2023)**

The aim of the course is to provide the basic 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 in 2 lessons (2 hours each) and a laboratory experience (4 hours) at the Radiogenic Isotope Geochemistry Laboratory of the Università degli Studi di Firenze.

Lesson 1 (2 hours): brief introduction to isotopes; chemical methods for sample purification through cation exchange chromatography; description of TIMS and MCICPMS and differences.

Lesson 2 (2 hours): 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 (4 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.

**MATTEO BELVEDERE (matteo.belvedere@unifi.it)**

**Close-range photogrammetry paleontology and museum heritage. From pictures to 3D models basics (16 ore, 2 CFU)**

**(DATE: to be defined with the participants – end of January-1st week of February 2023)**

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.

Registration deadline 10 January 2023

For information, final dates and registration please contact Dr. Matteo Belvedere: (matteo.belvedere@unifi.it)

**MARCO BENVENUTI (m.benvenuti@unifi.it)**

**Le georisorse metallifere in epoca pre-Industriale (8 ore, 1 CFU)**

**(DATE: to be defined with the students)**

Il corso si propone di offrire una sintetica panoramica delle georisorse minerarie dalle quali l'Uomo ha estratto metalli a partire dal tardo Neolitico fino all'avvento dell'Era industriale.

Argomenti del Corso in dettaglio:

Disponibilità geologica e tecnologica dei metalli

Minerali metalliferi

Il processo di estrazione metallurgica

Evoluzione storica della metallurgia

Metallurgia del rame e delle sue leghe

Metallurgia di ferro e acciaio

**ADELE BERTINI (adele.bertini@unifi.it)**

**QUATERNARY PALEOENVIRONMENTS AND PALEOCLIMATE IN THE MEDITERRANEAN AREA**

**A. BERTINI, N. COMBOURIEU-NEBOUT, NICCOLÒ DEGL'INNOCENTI, L. DUGERDIL, Y.MIRAS, G. NICCOLINI, O. PEYRON**

**(24 hours, 3 CFU)**

**(DATE: 5-7 DECEMBER 2022)**

3 days of lessons, with theoretical and practical contents.

The future of Mediterranean ecosystems and landscapes is clearly tied to water availability and global climate change. While modern vegetation data from the region provide a baseline for understanding relationships between aridity and vegetation composition, paleoecological records bring support for understanding vegetation

responses at longer time scales Paleocological records show that aridity, as a feature of the Mediterranean basin, appeared early, gradually increasing up to the present time Italy represents one of the most informative Mediterranean areas to (i) reconstruct the response of vegetation to various climatic stresses and (ii) assess the likely future behavior of Mediterranean plants Furthermore, the Italy's rich geological and stratigraphical record makes it (iii) a significant source of information on the history of Mediterranean.

### **Program**

#### **05.12.2022 University of Florence, DST, Via G. La Pira, 4 - Room SALA STROZZI**

09:00-11:00 Introduction to palynology. From the samples to the palynological slides

11:00-12:30 PRACTICAL PALYNOLOGY : Pollen morphology

14:00-16:00 Paleoenvironment and paleoclimate changes in the Mediterranean during the Quaternary

16:00-19:00 PRACTICAL PALYNOLOGY : exercises and applications

#### **06.12.2022 University of Florence, DST, Via G. La Pira, 4 - Room SALA STROZZI**

09:00-11:30 Multi method climate reconstructions from pollen data and comparison with other proxy inferred data

11:30-13:00 Mediterranean cases of study and application of transfer functions to reconstruct paleoclimatic parameters (T, P, ...)

14:00-19:00 PRACTICAL PALYNOLOGY exercises and applications

#### **07.12.2022 University of Florence, DST, Via G. La Pira, 4 - Room SALA STROZZI**

08:30-10:00 Palynofacies, a useful tool for the reconstruction of morphoclimatic systems

10:00-13:00 Non pollen palynomorphs as a complementary tool to reconstruct human environments

14:00-19:00 PRACTICAL PALYNOLOGY

14:00-16:00 Non pollen palynomorphs morphology

16:00-19:00 exercises and applications

Courses will be delivered on site and in videoconference with a link sent on request

For the inscription and information: [adele.bertini@unifi.it](mailto:adele.bertini@unifi.it)

**ADELE BERTINI ([adele.bertini@unifi.it](mailto:adele.bertini@unifi.it)) e FABIANO GAMBERI (ISMAR-CNR sede di Bologna)**

**SEQUENCE STRATIGRAPHY: PRINCIPLES AND APPLICATIONS THROUGH SEISMO-STRATIGRAPHIC AND PALYNOLOGIC ANALYSES. F. GAMBERI & A. BERTINI**

**(DATE: 19 DECEMBER 2022, 1 day, 8 hours: 9:00- 13:00 and 14:00- 18:00, 1 CFU)**

Introducing seismic stratigraphy Introducing sequence stratigraphy Processes controlling sedimentation and stratigraphic sequences Coastline Trends Seismics and sequence stratigraphy surfaces System tracts Depositional sequence IV Seismic facies and paleoenvironmental analysis Paleoenvironmental reconstructions of shelf edge

system tracts Paleoenvironmental reconstructions of system tracts in the continental slope Paleoenvironmental reconstructions of deep sea system tracts Palynofacies and palynomorphs (spores, dinocysts and other Non Pollen NPP Palynomorphs) to interpret environments and depositional sequences Description of the main palynological groups useful for deductions on sea level fluctuations and changes in the deposition environments (coastal, The transport of palynomorphs in the marine environment Examples of distribution of palynological associations according to onshore offshore transects and their relationship with the cycles of sequential stratigraphy. Case studies.

**Venue: University of Florence, DST, Via G. La Pira, 4 - Room SALA STROZZI**

Courses will be delivered on site and in videoconference with a link sent on request.

For the inscription and information: [adele.bertini@unifi.it](mailto:adele.bertini@unifi.it)

**SILVIA BIANCHINI ([silvia.bianchini@unifi.it](mailto:silvia.bianchini@unifi.it))**

**Tecniche di detection and mapping da dati radar interferometrici satellitari applicate all'instabilità del terreno e dei manufatti (8 ore, 1 CFU)**

**(DATE: giugno – luglio 2023)**

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.

**LUCA BINDI ([luca.bindi@unifi.it](mailto:luca.bindi@unifi.it))**

**Introduzione alla cristallografia aperiodica (6 ore, 1 CFU)**

**(DATE: to be defined with the students)**

Concetto di aperiodicità di una struttura cristallina; strutture modulate incommensurate; strutture modulate composite; quasicristalli; tecniche di indagine di materiali aperiodici e loro descrizione.

Il corso prevede solo lezioni frontali (6 ore).

Introduction to aperiodicity; incommensurately modulated structures; composite modulated structures; quasicrystals; how to study and describe an aperiodic material.

Only class lectures (6 hours).

**Cristallochimica di minerali del mantello (6 ore, 1 CFU)**

**(DATE: to be defined with the students)**

Transizioni di fase olivina → wadsleyite e wadsleyite → ringwoodite. Incorporazione di elementi minori in fasi di alta pressione (majorite, akimotoite, ringwoodite, bridgmanite, fasi post-spinello). Analogie tra minerali di alta pressione terrestri e loro equivalenti nelle meteoriti.

Il corso prevede solo lezioni frontali (6 ore).

Phase transitions olivine → wadsleyite and wadsleyite → ringwoodite; Incorporation of minor elements in high-pressure phases (majorite, akimotoite, ringwoodite, bridgmanite, post-spinel phases); Analogies between terrestrial high-pressure minerals and their analogues in meteorites.

Only class lectures (6 hours).

**ANTONELLA BUCCIANI (antonella.buccianti@unifi.it)**

**Dynamics of environmental complex systems (8 ore, 1 CFU)**

**(DATE: to be defined)**

The study of complex systems in a unified framework has become recognized in recent years as a new scientific discipline, the ultimate of interdisciplinary fields. Complex systems are often subject to multiple environmental drivers. For a system with alternative stable states pressure on an environmental driver pushes the system closer to a tipping point. Once the driver crosses a certain threshold the system goes through a critical transition and shifts to a different state, thus modifying its behavior. The aim of the course is to provide the basic knowledge and tools to investigate the dynamic of complex environmental systems between stability, resilience and variability.

The course is organized in 2 lessons of 4 hours each and will be held at the Department of Earth Science of the University of Florence.

Lesson 1: An Introduction to the dynamics of complex systems: What are complex systems and what properties characterize them. Central properties of complex systems. Emergence: from elements and parts to complex systems. Relationships between the parts: nonlinearity, spontaneous order, self-organization, adaptation and feedback loops.

Lesson 2: Methodological tools: Mathematical, statistical and thermodynamic approaches. Environmental changes at the boundary between Euclidean and fractal geometries. The role of CoDA (Compositional Data Analysis) theory in the analysis of environmental matrices.

**RAFFAELLO CIONI (raffaello.cioni@unifi.it) PIETRO GABELLINI**

**(pietro.gabellini@unifi.it)**

**DATE: (15 June-15 July 2023 to be defined with the students)**

**32 ore – 3 CFU**

**Metodi di analisi tessiturali di rocce vulcaniche**

Il corso si propone di introdurre gli studenti ai diversi metodi di analisi delle tessiture di rocce vulcaniche, con particolare riguardo allo studio delle masse di fondo, ed alla interpretazione dei risultati in termini vulcanologici. Il corso è organizzato in 3 ore di lezioni teoriche ed in 5 ore di esercitazioni pratiche, durante le quali gli studenti utilizzeranno i principali software per l'analisi di immagine e la correzione stereologica dei dati, e discuteranno i risultati ottenuti.

### **Morphometric characterization of clastic materials through image analysis**

Il corso è strutturato per essere erogato in 2 giornate (di 8 ore ciascuna).

E' possibile posticipare o frazionare in modo differente le ore a disposizione, previo accordo, con il docente.

The course provides an introduction to the most used techniques available for the digital image processing and analysis. It is focused to train the students on the extraction of quantitative information from 2D and 3D images (es. SEM images) and on the morphometrical characterization of several types of natural, clastic materials (eg. volcanic ash, solid atmospheric particulate, sand or loose sediments).

The course involves a first unit dedicated to the theory of the image analysis, with a brief review of the parameters used to quantify the morphometrical aspects of irregular shapes in 2D and 3D. Then, the students will be introduced and trained to the use of the software ImageJ (Fiji; open domain), using various test images and real-life examples. Finally, students will be guided through the analysis of a granular deposit using the automatic particle analyzer (Malvern Morphologi G3s) available in the labs of the University of Florence.

**ELENA DELLA SCHIAVA (elenadellaschiava@libero.it)**

### **Indagini sui beni culturali durante il restauro: le terre di fusione di alcune sculture bronzee di Donatello e di altri autori del Rinascimento fiorentino (6 ore, 1 CFU) (DATE: marzo 2023 to be defined with the students)**

- Introduzione

(spiegazione dei lavori eseguiti, foto, esempi di alcune indagini su varie opere, obiettivi raggiunti)

- Cosa sono le terre di fusione nello specifico; le tecniche di fusione (foto, esempi, campioni di terre, opere, realizzazione di una scultura)

- Le tecniche analitiche per caratterizzare le terre

- Lo stato dell'arte sulle terre di fusione delle sculture (articoli di restauro, scientifici, bibliografie e letteratura)

- Considerazioni tecnologiche

(il contributo alle indagini tecnologiche dei bronzi dato dagli studi sulle terre)

- Problematiche di conservazione delle terre in situ nelle statue (svuotamento, fenomeni di interfaccia metallo/anima)

- Come campionare le terre di fusione per ottimizzare i risultati analitici

- Campioni di terre: carrellata di esempi pratici di opere d'arte con visione di campioni prelevati
- Le terre di fusione del San Giovanni Battista (1571) di Vincenzo Danti (campionamento, indagini, obiettivi, risultati)
- Le terre di fusione di alcune sculture donatelliane realizzate fra gli anni '20 e '60 del XV secolo (campionamento, indagini, obiettivi, risultati)
- Conclusioni.

**WILLIAM FRODELLA (william.frodella@gmail.com)**

**Termografia a infrarossi applicata alla caratterizzazione dei fenomeni franosi e alla protezione dei beni culturali sottoposti a rischio idrogeologico (16 ore, 2 CFU)**

**(DATE: June 2023 to be defined with the students)**

Il corso si pone come obiettivo fornire le conoscenze teoriche e pratiche di base sulla termografia a infrarossi applicata alla caratterizzazione dei fenomeni franosi e alla protezione dei beni culturali sottoposti a rischio idrogeologico.

Il corso è articolato in lezioni frontali incentrate su cenni teorici di base, sensori e termocamere a infrarossi, utilizzo del software di analisi termografica FLIR Tools+, applicazioni e illustrazione di casi di studio, pianificazione di un rilievo termografico. Una parte rilevante del corso sarà dedicata a esercitazioni pratiche articolate in rilievi termografici, analisi ed interpretazione dei termogrammi, organizzazione e stesura di un report termografico.

**CATERINA GOZZI (1) (caterina.gozzi@unifi.it)**

**Introduction & Basics of R (8 ore, 1CFU)**

**(DATE: 2<sup>nd</sup> half of June 2023)**

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 basics to start using the R software. The course is organized in 2 lessons of 4 hours each and will be held at the Department of Earth Science of the University of Florence.

Lesson 1: An Introduction to R: How to install R and RStudio, launching RStudio, overview of the key components and features available, commands, operators and functions, help window.

Lesson 2: R applications to Earth Sciences: practical exercises in R using a geochemical dataset: reading data into the software, basics of research statistics, exploratory data analysis and production of different types of plots in ggplot2 and plotly packages (e.g. histograms, box-plots, bubble plots and correlations matrices)

**CATERINA GOZZI (2) (caterina.gozzi@unifi.it)**

## **Writing the PhD Thesis in LaTeX (4 ore, 0.5 CFU)**

**(DATE: 2<sup>nd</sup> half of May 2023 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 to start typesetting a PhD thesis using LaTeX. The course is organized in 2 lessons of 2 hours each and will be held at the Department of Earth Science of the University of Florence.

Lesson 1: An Introduction to LaTeX: The advantages of using LaTeX, typesetting text, font types, LaTeX environments, packages and templates.

Lesson 2: How to Write the Thesis in LaTeX: basic structure, sectioning, crossreferences, tables and figures, bibliography generation with Bibdesk.

## **GIOVANNI ORAZIO LEPORE (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**

**(14 ore, 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.

## **ROSAROSA MANCA (rosarosa.manca@unifi.it)**

**Applications of X-rays based techniques for the non-invasive characterization of geomaterials in cultural heritage (6 hours, 1 CFU)**

**(date: March-June 2023 - 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, glazed pottery and paintings will be examined.

Part 1: Introduction on Geomaterials and Cultural Heritage. Non-invasive approaches: advantages and limitations. X-rays Fluorescence (XRF) spectroscopy, Particle-Induced 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.
- c) XRF, PIXE-PIGE analysis of paintings, drawings and books. The importance of map analyses.

**EMANUELE MARCHETTI (emanuele.marchetti@unifi.it)**

**Infrasound array analysis of gravity currents (16 ore, 2 CFU)**

**(June-September 2023 to be defined with the students)**

- Introduction to time series analysis (spectral analysis, filtering, coherence and crosscorrelation)
- Infrasound acoustics, source mechanisms and array analysis.
- Source mechanisms of different gravity currents, (snow avalanches, debris flows, calving events, PDC)
- Fluid dynamics modeling of pressure waveforms.
- Real-time application for event detection, identification and notification.
- Implication for research and monitoring.

**CLAUDIO NATALI (claudio.natali@unifi.it)**

**Identificazione di tenori di fondo geogenici e anomalie di origine antropogenica in sistemi ambientali (8 ore, 1 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.

**LUCA PANDOLFI, SAVERIO BARTOLINI LUCENTI, LORENZO ROOK**

([lorenzo.rook@unifi.it](mailto:lorenzo.rook@unifi.it))

Laboratorio di Paleontologia dei Vertebrati (Paleo[Fab]Lab)

**Advanced course in Vertebrate Paleontology: Applicative methods and analytic tools (6 CFU)**

**(DATE: to be defined with the students)**

The course (6 CFU) is organized in five lesson-days, with theoretical and practical contents and individual work by the students. The course provides an overview on the discipline of Vertebrate Paleontology, in particular on the investigation of Neogene and Quaternary mammals by means of different new approaches. Fossil mammals provide insightful data on evolutionary patterns, adaptations and environmental changes as well as on the origin of extant taxa. Classical morphological and morphometric comparisons have been extensively applied in several studies on fossil species. In recent times, researchers are investigating morphological changes and evolution by means of additional new methodologies and analytical tools. Students will be introduced to a general framework on classical and advanced methods to investigate evolution and morphological changes in mammals and to apply comprehensive analyses in the study of fossil vertebrates. Case-studies on the use of different methods to analyze evolutionary patterns in Eurasian and African fossil mammals will be presented.

About the teachers:

Ø Dr. Luca Pandolfi is a Research Fellow at the University of Florence, responsible of the project Ecomorphology of fossil and extant Hippopotamids and Rhinocerotids.

Ø Dr. Saverio Bartolini Lucenti is a Research Fellow at the University of Florence, responsible of the project PalVirt (Virtual paleontology, a non-invasive approach and for the use, diffusion and sharing of the paleontological heritage).

The number of participants is limited to 8. The course is primarily addressed to doctoral and master students of Tuscan universities. Doctoral and master students from other universities are also welcomed, and will be admitted following the order in which applications are received (until the maximum number has been reached).

**FEDERICO SANI ([federico.sani@unifi.it](mailto:federico.sani@unifi.it))**

**Corso di Interpretazione geologico-strutturale di profili sismici a riflessione (24 ore, 3 CFU)**

**(DATE: to be defined with the students)**

Il corso si propone di fornire le conoscenze di base per l'interpretazione di profili sismici a riflessione.

Dopo una breve introduzione alle modalità di acquisizione ed elaborazione del dato sismico, finalizzata soprattutto alle implicazioni per l'interpretazione, verranno

richiamati alcuni aspetti generali delle strutture, con particolare riguardo ai rapporti tra tettonica e sedimentazione. Verranno studiate sezioni in vari ambienti geodinamici, dai rift continentali alle catene collisionali, oltre alla tettonica salina e d'inversione.

Saranno affrontati problemi relativi all'individuazione delle principali strutture, alle relazioni stratigrafiche tra i vari corpi sedimentari, alla conversione tra tempi e profondità e alla correlazione con pozzi eventualmente disponibili.

Infine per ogni sezione analizzata e interpretata sarà proposta una ricostruzione evolutiva dell'area analizzata.

**SAMUELE SEGONI** ([samuele.segoni@unifi.it](mailto:samuele.segoni@unifi.it)) (organizer)

1st IITI-UNIFI workshop on landslide hazard forecasting, monitoring and early warning (8 hours, 1 CFU)

(DATE: 9 and 10 February 2023, 9:00-13:00 Italian time)

This is a workshop co-organized by the Department of Earth Sciences of UNIFI and the Civil Engineering Department of Indian Institute of Technology Indore. The workshop is conceived as an event to disseminate the latest advances obtained by the scholars of the two aforementioned institutions in the field of landslide studies (spanning mainly through landslide hazard and risk mapping, modeling, monitoring, forecasting, warning, and management). The workshop also promotes past and future joint research activities and has the objective to find common points of interest to foster a future cooperation between Italian and Indian scholars (both researchers and PhD students). The workshop is divided into four blocks. Each block (45' talk + 10' discussion + 45' talk + 10' discussion + 10' coffee break) addresses a specific topic and is covered by two speakers, as summarized below:

- Regional scale early warning systems (talks by S. Segoni and R.K. Bhandari).
- Distributed physically based models (talks by V.Tofani and D.P. Kanungo).
- Instrumental monitoring/ground based remote sensing (talks by T. Carlà and T.K. Bharat).
- Slope scale forecasting and early warning (talks by E. Intrieri and N. Satyam).

The event will be organized in dual mode: remote participation will be possible on the Teams platform, while on-site participation will take place in Florence (exact place and possibility of a free Indian light lunch will be confirmed in January 2023 to all registered participants).

Registration is mandatory, please write an email to [samuele.segoni@unifi.it](mailto:samuele.segoni@unifi.it)

**MARTA MORANA** ([marta.morana@unifi.it](mailto:marta.morana@unifi.it))

**1) HIGH-PRESSURE EXPERIMENTAL TECHNIQUES-METODI SPERIMENTALI AD ALTA PRESSIONE**

**(16 ore, CFU 2)**

**(Date: June 2023 to be defined with the students)**

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**

**(16 ore, CFU 2)**

**(Date: June 2023 to be defined with the students)**

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.

**ROBERTO EMANUELE RIZZO ([robertoemanuele.rizzo@unifi.it](mailto:robertoemanuele.rizzo@unifi.it))**

**Faults and fractures networks in geoenergy applications**

**(8 ore, 1 CFU)**

**(DATE: 2nd half of June 2023 to be defined with the students)**

Faults and fracture zones are fundamental features of geological reservoirs that control the physical properties of the rock. As such, understanding their role in in-situ fluid behavior and fluid-rock interactions can generate considerable advantages during exploration and management of reservoirs and repositories.

Review on the physical properties such as frictional strength, cohesion of faulted and fractured rock masses.

Statistical analysis of fault and fracture networks and their implications in fluid transport in the subsurface.

Modelling of fluid permeability of fractured rock masses.

**DANIELE MAESTRELLI ([daniele.maestrelli@igg.cnr.it](mailto:daniele.maestrelli@igg.cnr.it))**

**Analogue modelling of volcano-tectonic processes: from nature to lab**

**(16 ore, 2 CFU)**

**(DATE: June 2023 to be defined with the students)**

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.

**EMANUELE INTRIERI (emanuele.intrieri@unifi.it)**

**Previsione e allertamento di frane a scala di versante mediante monitoraggio degli spostamenti (8 ore, 1 CFU)**

**LAndslide forecasting and warning at slope scale using displacement monitoring (8 hours, 1 CFU)**

**(DATE: da aprile a luglio da concordarsi con gli studenti)**

**DATES: from April to July to be scheduled together with students.)**

I principali argomenti trattati saranno i seguenti:

- progettazione di un sistema di allertamento per frana a scala di versante: definizioni, tipologie di sistemi di allertamento, criteri di progettazione, esercitazione pratica mediante simulazione di un sistema di allertamento, casi di studio, sistemi di monitoraggio vari, diagramma di flusso decisionale;
- monitoraggio: tecniche di monitoraggio finalizzate all'allertamento, trasmissione big data, radar interferometrico basato a terra;
- metodi di previsione dell'istante di collasso: descrizione dei metodi esistenti, limiti di utilizzo, metodi per la previsione spaziale, casi di studio;
- comunicazione: ruolo della comunicazione per la riduzione del rischio da frana, linee guida per la comunicazione del rischio, piani di protezione civile.

Contattare il docente entro il 15 aprile per concordare le date da fine aprile a inizio luglio.

The main topics covered will be the following:

- design of a landslide warning system at slope scale: definitions, types of early warning systems, design criteria, practical exercise by simulating an alert system, case studies, monitoring systems, decision flowchart;
- monitoring: monitoring techniques aimed at warning, transmission of big data, ground-based interferometric radar;
- methods to forecast the time of failure: description of existing methods, limitations, methods for spatial prediction, case studies;
- communication: role of communication in landslide risk reduction, risk communication guidelines, civil protection plans.

Contact the teacher by 15 April to agree on dates from the end of April to the beginning of July