Research Project Ideas

Proponent (Tutor)	Project title	Research field(s)
Prof. S. Albanese	Probabilistic environmental radiological risk assessment in the Vesuvius area using coupled in-situ monitoring and Monte Carlo stochastic modeling	Applied Geochemistry and Environmental Risks
Prof. V. Allocca	Numerical hydrogeological modeling of solute and heat flow transport in active volcanic areas (Somma-Vesuvius and Campi Flegrei) of the Campania region	Engineering Geology and Hydrogeology; Geochemistry
Prof. D. Calcaterra	Regime transitions in intermittent-kinematics landslides: forcing patterns, mechanisms of catastrophic shifts, and their anticipation	Engineering Geology and Hydrogeology
Prof. P. De Vita	Integrated study of spring emergencies in southern Italy by analysis of data sources, hydrogeological characterization and monitoring	Engineering geology and hydrogeology
Prof. D. Di Martire	Scientific Validation of EGMS Copernicus InSAR Products for Natural Hazard Monitoring Using AI-Based Approaches	Engineering Geology; Earth Observation
Prof. G. Florio	Gravity anomaly analysis for the geophysical characterization of rocky planets	Imaging and inversion of geophysical data; Geophysical exploration and modelling of natural hazards
Prof. V. Guarino	From Mantle Source to Potential Diamond Resource: New Perspectives on Brazilian Kimberlite Systems	Petrology and Petrography
Dott. L. Guerriero	Pore-Pressure Feedbacks and Velocity Regulation in Landslides: From Shear-Zone Processes to Landslide-Scale Dynamics	Engineering Geology and Hydrogeology; Geotechnical Engineering
Prof. F. Izzo	Functionalized Natural Zeolites and Microporous Minerals for Environmental Protection and Remediation	Mineralogy; Applied Mineralogy
Prof. W. Marzocchi	Volcanic hazards for the risks management at Campi Flegrei, Italy	Geophysics - Probabilistic eruption forecasting and volcanic hazard; Geophysics - Seismic hazard and probabilistic earthquake forecasting; Volcanology and Physics of Volcanism
Prof. V. Morra	Production and circulation of archaeological ceramics in Campania	Archaeometry and Cultural Heritage; Petrology and Petrography; Applied Mineralogy
Prof. P. Petrosino	Thermo-Mechanical Regulation of Fluid Transfer in the Somma-Vesuvio volcanic system: Evidence from Experimental and Petrological Data	Volcanology and Physical Volcanology; Petrography and Petrology
Prof. E. Piegari	Maximizing information extraction from seismic catalogs through machine learning: 3D fault geometry reconstruction and interactions for seismic hazard assessment	Earthquake forecasting and seismic hazard; Tectonics, Structural Geology and related Hazards
Prof. F. Putzolu	Origin of high-grade (illite-type) volcano-sedimentary Li mineralization	Mineral Deposits; Applied Mineralogy; Isotope Geochemistry
Prof. L. Repola	Digital Cultural Landscapes. 3D Digitization Processes and AI Tools for Modeling Applied to the Management, Analysis, and Visualization of Geospatial Data	Archaeometry and Cultural Heritage
Prof. G. Russo	Experimental Investigation of Conditioning Agent–Clay Interactions for the Reuse of Excavated Materials from Mechanized Tunnelling	Geotechnical Engineering
Prof. N. Scafetta	From Global Models to Local Realities: Climate Downscaling and Adaptation Indicators for Vulnerable Countries	Meteorology, Climatology and Oceanography
Prof. S. Vitale	Reconstruction of the deep structure of the Campi Flegrei caldera and of the kinematics in space and time of the main volcano-tectonic structures	Tectonics, Structural Geology and related Hazards; Geophysical exploration and modelling of natural hazards; Volcanology and Physics of Volcanism

ENGLISH

Proponent (Tutor)*

Prof. Stefano Albanese

Other Proponent(s) (Co-Tutor)

Dr. Giancarlo Germano (Centro Regionale radioattività - ARPA Campania)

Research Area(s) (Max. 3):*

- Applied Geochemistry and Envionmental Risks

Main ERC Sector

PE10_11 Geochemistry, crystal chemistry, isotope geochemistry, thermodynamics

Subject/Title of the scientific project idea *

Probabilistic environmental radiological risk assessment in the Vesuvius area using coupled in-situ monitoring and Monte Carlo stochastic modeling

Research proposal (max 200 words)

This project aims to assess the radiological risk from natural (geogenic and anthropogenic) sources for the population in the Vesuvius area, a volcanic setting known for high concentrations of primordial radionuclides. The main goal is to overcome the limitations of traditional deterministic assessments by introducing a stochastic approach.

The research involves planning a regional sampling campaign to simultaneously measure the external gamma radiation dose rate (both indoor and outdoor) and Radon (Rn-222) gas concentrations in confined spaces and soil. The experimental data, combined with the variability of human behavioral factors, will be integrated as probability density functions within a Monte Carlo simulation algorithm. This method will enable the development of GIS-based predictive maps displaying the probability of exceeding annual effective dose thresholds and the Excess Lifetime Cancer Risk (ELCR). The outcomes will deliver an advanced statistical framework, serving as a crucial tool for urban planning and the delimitation of priority areas in compliance with current European and national radioprotection regulations.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent (Tutor)*

Prof. Vincenzo Allocca

Other Proponent(s) (Co-Tutor)

Prof. De Vita Pantaleone; Dott. Stefano Caliro

Research Area(s) (Max. 3):*

Use the research areas list attached to the email, derived from the DiSTAR departmental website

1. Engineering Geology and Hydrogeology
2. Geochemistry

Main ERC Sector

Use the ERC sectors list attached to the email (e.g., PE10_4 Terrestrial ecology, land cover change)

PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution

Subject/Title of the scientific project idea *

Numerical hydrogeological modeling of solute and heat flow transport in active volcanic areas (Somma-Vesuvius and Campi Flegrei) of the Campania region.

Research proposal (max 200 words)

The Somma-Vesuvius and Campi Flegrei volcanic systems are characterized by groundwater used for drinking, thermal-mineral, industrial, and irrigation purposes. Numerical hydrogeological modeling is crucial for sustainable aquifer management and prevention of geological risks (e.g., pollution, overexploitation, bradyseism). An integrated approach, based on multi-parametric and multi-level monitoring and the use of stratigraphic, hydrogeological, hydrogeochemical, isotopic, geophysical, and meteorological data, is essential for multi-scale modeling of aquifer systems, the analysis of mineralization processes and volcanic and bradyseismic activity. Hydrogeological modeling will support understanding hydrological behavior of aquifers and predicting responses to natural (climatic, bradyseismic, volcanic) and/or anthropogenic (pumping) forcings. The proposed topic aims to implement a methodological tool for the study, understanding of resources, and risk prevention in active volcanic areas such as Somma-Vesuvius and the Phlegraean Fields, which can also be transferred to other volcanic areas in Italy. This methodological tool can support decision-making, hydrogeological, volcanological, and bradyseismic monitoring and surveillance, sustainable use of groundwater and implemt technologies for the energy transition.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent (Tutor)*

Prof. Domenico Calcaterra

Other Proponent(s) (Co-Tutor)

Dr. Luigi Guerriero

Research Area(s) (Max. 3):*

1. Engineering Geology and Hydrogeology

Main ERC Sector

PE10_20 Geohazards: earthquakes, landslides, tsunamis and other ground instabilities
PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution

Subject/Title of the scientific project idea *

Regime transitions in intermittent-kinematics landslides: forcing patterns, mechanisms of catastrophic shifts, and their anticipation

Research proposal (max 200 words)

Intermittent landslides (sometimes incorrectly referred to as "slow-moving") represent one of the most pervasive geohazards in Italy, characterized by long-term persistence across diverse geological settings. Instead of experiencing a single failure followed by stabilization, these events reactivate cyclically, responding to hydrological forcing with displacement behaviors oscillating between slow movement and suddern catastrophic acceleration. While conventional research frameworks investigate these reactivations as discrete phenomena triggered by single external drivers (e.g., rainfall or earthquakes), effectively anticipating catastrophic slope dynamics requires a fundamental paradigm shift. Periodically reactivating slow-moving landslides should not be treated as isolated systems acting linearly to external triggers, but as complex dynamical systems evolving through successive, non-linear deformation regimes. The core of this research field lies in the hypothesis that slope systems exhibit measurable, multi-physical transition signatures. The transition from slow movement to catastrophic acceleration is the observable expression of evolving internal state variables such as pore-pressure redistribution, progressive weakening, hydrological memory, and rate-dependent rheology. Consequently, identical external forcings can yield fundamentally different kinematic responses depending on the current internal state of the slope. Unraveling internal state, forcing patterns and triggering mechanisms such as the shift from dilatant strengthening to contractive weakening, stress-induced viscosity reduction, or rate-weakening behavior represents major challenges in landslide forecasting.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent (Tutor)*

Prof. Pantaleone De Vita

Other Proponent(s) (Co-Tutor)

Prof. Vincenzo Allocca
Dott. Daniele Lepore

Research Area(s) (Max. 3):*

1. Engineering geology and hydrogeology

Main ERC Sector

PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution

Subject/Title of the scientific project idea *

Integrated study of spring emergencies in southern Italy by analysis of data sources, hydrogeological characterization and monitoring

Research proposal (max 200 words)

Knowledge of spring emergencies in southern Italy is a fundamental acquisition for the management of water resources. Unlike many other geological themes, it represents one of the few pieces of territorial knowledge not yet developed organically and implemented in usable geodatabases. This is the focus of the SORGEO - SORgenti GeodatabaseGEO activity of the GEOSCIENCES RISE project, funded by the MUR, in the framework of which the PhD is proposed. The aims of the program are the development of an integrated approach to reconstruct, validate and enhance the heritage of springs in southern Italy, combining historical analysis, geodatabases, on-site monitoring and satellite data. Among the main objectives are the digitization and validation of the historical census of the springs, dating back extensively to the 30s and 40s of the last century, the reconstruction of a georeferenced geodatabase with quantitative measurements and chemical-physical characteristics, the acquisition andprocessing of COPERNICUS and CHELSA data (precipitation, temperature, land use, evapotranspiration) and high-resolution meteorological radar data for climate characterization and estimation of charging processes and the implementation of a remote monitoring network on representative sources. The expected results will improve the hydrogeological characterization of the territory and provide digital solutions for geotourism use.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent (Tutor)*

Prof. Di Martire

Other Proponent(s) (Co-Tutor)

Prof. Calcaterra

Research Area(s) (Max. 3):*

1. Engineering Geology
2. Earth Observation

Main ERC Sector

PE10_15 Earth observations from space/remote sensing
SH3_4 Geographical information systems, cartography
SH3_6 Spatial and regional planning

Subject/Title of the scientific project idea *

Scientific Validation of EGMS Copernicus InSAR Products for Natural Hazard Monitoring Using AI-Based Approaches

Research proposal (max 200 words)

This research focuses on the scientific validation and interpretation of ground motion products derived from the European Ground Motion Service (EGMS), developed within the Copernicus Land Monitoring Service. EGMS delivers harmonized deformation data at continental scale, including line-of-sight (LOS) velocities, calibrated displacement time series, and vertical and east-west motion components, based on long-term Sentinel-1 observations.

The project evaluates EGMS reliability across a range of natural hazards using Italy as a natural laboratory given its diverse lithological, geomorphological, and geohazard settings. Validation is conducted through quantitative assessment of accuracy and temporal consistency, evaluation of uncertainty realism, and thematic comparison against authoritative hazard inventories and in-situ reference measurements including GNSS time series and velocities.

A key innovation of this research is the integration of Artificial Intelligence and Machine Learning techniques into the validation workflow. AI-based approaches will support automated anomaly detection, pattern recognition in deformation time series, and discrimination between real ground motion signals and InSAR artefacts. The combination of Copernicus satellite products, in-situ references, and AI-driven analysis aims to produce robust, reproducible guidelines for scientific and institutional users on the reliability and limitations of EGMS products across different natural hazard contexts.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent (Tutor)*

Prof. Giovanni Florio

Other Proponent(s) (Co-Tutor)

Dott. Maurizio Milano

Research Area(s) (Max. 3):*

1. Imaging and inversion of geophysical data
2. Geophysical exploration and modelling of natural hazards

Main ERC Sector

PE10_15 Earth observations from space/remote sensing

Subject/Title of the scientific project idea *

Gravity anomaly analysis for the geophysical characterization of rocky planets

Research proposal (max 200 words)

The project aims to investigate the structure of rocky planets through the processing, analysis, and modeling of satellite-derived gravity data. The study of gravity anomalies is fundamental in planetary science, as it provides insights into mass distribution and enables indirect investigation of the internal structure of planetary bodies.

Gravity data analysis allow the identification and characterization of major geological and tectonic features, including impact basins, volcanic systems, large magmatic provinces, and crustal discontinuities, providing information on their extent both at the surface and at depth. The project will place strong emphasis on research into non-parametric methods to mitigate the ambiguity of geophysical modeling and the scarcity of available constraints. Through these processing and modeling techniques, it will be possible to reconstruct the subsurface density distribution and formulate hypotheses on the geodynamic processes that have guided planetary evolution.

The integration of gravity observations with other geophysical and geological datasets, such as topographic, altimetric, and geochemical data, will provide a more comprehensive understanding of the structure and evolution of rocky planets. The results will contribute to improving our knowledge of the processes controlling planetary formation and evolution, with particular emphasis on Mars, Mercury, the Moon, and Venus.

ENGLISH

Proponent (Tutor)*

Prof. Vincenza Guarino

Other Proponent(s) (Co-Tutors)

Prof. Rogério G. Azzone and Prof. Luanna Chymz (Department of Mineralogy and Geotectonics - University of São Paulo, Brazil)

Research Area(s) (Max. 3):*

1. Petrology and Petrography

Main ERC Sector

PE10_10 Mineralogy, petrology, igneous petrology, metamorphic petrology
PE10_11 Geochemistry, crystal chemistry, isotope geochemistry, thermodynamics

Subject/Title of the scientific project idea *

From Mantle Source to Potential Diamond Resource: New Perspectives on Brazilian Kimberlite Systems

Research proposal (max 200 words)

This project aims to study two kimberlite bodies from the Brazilian Platform using an integrated approach that includes petrography, mineralogy, geochemistry, and isotope analysis. The study will focus on characterizing the composition of key minerals observed as xenocrysts, crystals, and xenoliths. This will improve our understanding of mantle source characteristics, magma evolution, and processes related to diamond fertility.

The study will emphasize distinguishing between mantle-derived xenocrysts and magmatic phenocrysts and antecrysts in order to reconstruct the complex history of kimberlite magmatism. Mineral chemistry will be used to estimate intensive parameters such as pressure, temperature, and oxygen fugacity and to evaluate the effects of mantle metasomatism. Detailed investigations of zoning patterns, crystal textures, and different mineral populations will provide insight into magma ascent, storage, crustal interaction, and open-system processes.

The resulting dataset will be integrated with thermodynamic and geochemical modeling to constrain the evolution of kimberlite magmas from their mantle sources to their emplacement. Finally, the project aims to establish links between mantle processes, kimberlite petrogenesis, and the development of economically significant, diamond-bearing systems within the Brazilian cratonic provinces.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent (Tutor)*

Dott. Luigi Guerriero

Other Proponent(s) (Co-Tutor)

Prof. Giacomo Russo

Research Area(s) (Max. 3):*

1. Engineering Geology and Hydrogeology
2. Geotechnical Engineering

Main ERC Sector

PE10_20 Geohazards: earthquakes, landslides, tsunamis and other ground instabilities
PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution
PE8_3 Civil engineering, maritime/hydraulic engineering, geotechnics, waste treatment

Subject/Title of the scientific project idea *

Pore-Pressure Feedbacks and Velocity Regulation in Landslides: From Shear-Zone Processes to Landslide-Scale Dynamics

Research proposal (max 200 words)

Landslides often exhibit persistent displacement over years to century despite continuous hydrological fluctuations. Although variations in pore-water pressure are commonly invoked to explain changes in landslide activity, field observations frequently reveal complex and non-linear relationships between hydrological forcing and displacement rate. This suggests that landslide velocity is not controlled solely by external inputs, but also by internal hydro-mechanical feedbacks operating within the shear zone. The shear zone is increasingly recognized as a dynamic component of the landslide system, where deformation, volume changes, drainage conditions, and pore-pressure evolution interact to govern effective stress and shear resistance. Depending on the hydraulic state of the material and its tendency to dilate or contract during deformation, pore pressures may either decrease or increase, promoting stabilizing or destabilizing responses. These mechanisms may explain why some landslides maintain remarkably steady rates of movement despite significant seasonal hydrological fluctuations, whereas others exhibit episodic accelerations or progressive transitions toward instability. Understanding how pore-pressure generation and dissipation are coupled with shear-zone deformation is therefore essential for advancing the physical interpretation of slow-moving landslides. Improved knowledge of these feedback processes could provide a robust framework for linking laboratory-scale mechanisms with landslide-scale behaviour and developing reliable process-based models of landslide evolution.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent (Tutor)*

Prof. Francesco Izzo

Other Proponent(s) (Co-Tutor)

Prof. Alessio langella

Research Area(s) (Max. 3):*

1. Mineralogy
2. Applied Mineralogy

Main ERC Sector

PE10_10 Mineralogy, petrology, igneous petrology, metamorphic petrology
PE5_3 Surface modification

Subject/Title of the scientific project idea *

Functionalized Natural Zeolites and Microporous Minerals for Environmental Protection and Remediation

Research proposal (max 200 words)

This research project focuses on the characterization, modification, and application of natural zeolites and other microporous minerals for environmental remediation purposes. The study will investigate the mineralogical, crystal-chemical, textural, and surface properties of these materials, as well as the effects of physical and chemical functionalization on their reactivity and performance.

Particular attention will be devoted to understanding the mechanisms governing ion exchange, adsorption, and surface interactions between mineral substrates and a wide range of environmentally relevant contaminants. These may be represented by potentially toxic elements, including metals and metalloids, nutrients, organic pollutants, pharmaceutical compounds, and other emerging contaminants commonly occurring in natural waters, wastewaters, and soils.

The project will combine advanced mineralogical and geochemical characterization techniques with laboratory-scale experiments aimed at evaluating the efficiency, selectivity, and long-term stability of natural and modified materials under different environmental conditions. Potential applications will include water and wastewater treatment, soil remediation, mitigation of environmental pollution, and recovery of valuable resources.

The ultimate goal is to develop sustainable, cost-effective, and environmentally friendly mineral-based solutions, contributing to the advancement of applied mineralogy and the development of innovative technologies for environmental protection and resource management.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent (Tutor)*

Prof. W. Marzocchi

Research Area(s) (Max. 3):*

1. Geophysics - Probabilistic eruption forecasting and volcanic hazard
2. Geophysics - Seismic hazard and probabilistic earthquake forecasting
3. Geochemistry, Mineralogy, Petrology, Volcanology, Mineral Resources and Applications - Volcanology and Physics of Volcanism

Main ERC Sector

PE10_5 Geology, tectonics, volcanology

Subject/Title of the scientific project idea *

Volcanic hazards for the risks management at Campi Flegrei, Italy

Research proposal (max 200 words)

Advances in our understanding of volcanic processes and past events allow for the continuous updating and improvement of modelling methods and forecasting tools, which are the foundation of hazard studies. These improvements make it possible to constantly revise hazard estimates, thereby changing the scientific reference framework used to define risk-reduction actions.

Emergency planning at Campi Flegrei, both for eruptive phenomena and for those associated with bradyseism, is based on actions and maps entirely derived from the hazard analyses available at the time they were developed. The ongoing unrest phase has made it possible to accumulate substantial knowledge about the Campi Flegrei volcanic system and about non-eruptive hazards during periods of unrest.

This project aims to analyse recent advances in hazard studies related to the various phenomena, both eruptive and non-eruptive, at Campi Flegrei, in light of new scientific insights and the latest developments in multi-hazard and multi-risk assessment. This will improve the body of knowledge available to the Civil Protection System, providing information useful for updating and, if necessary, revising emergency planning.

ENGLISH

Proponent (Tutor)*

Prof. Vincenzo Morra

Other Proponent(s) (Co-Tutor)

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Research Area(s) (Max. 3):*

1. Archaeometry and Cultural Heritage
2. Petrology and Petrography
3. Applied Mineralogy

Main ERC Sector

SH6_1 Archaeology, archaeometry, landscape archaeology

Subject/Title of the scientific project idea *

Production and circulation of archaeological ceramics in Campania

Research proposal (max 200 words)

The Campania region is renowned for its rich archaeological record, with ceramics representing the most widespread evidence of material culture. The study of ceramic production and the identification of imported objects are essential for reconstructing commercial and cultural exchanges among ancient populations. Additionally, the study of ceramics provides insight into the technologies used to make these artefacts, including the sourcing of clay raw materials, processing methods, and firing dynamics. Archaeometric investigation, using a mineralogical-petrographic approach, plays a key role in the study of archaeological ceramics. For many years, the DiSTAR archaeometric research group has produced numerous studies and a large compositional database of ceramics and clays, providing an overview of ceramic production and technologies across various historical periods at the main archaeological sites in Campania, such as Pompeii, Cumae, Neapolis, Paestum, Velia, and other regional sites.

The goal is to expand this research by analysing ceramics from carefully selected case studies in collaboration with archaeologists and comparing the results with previous data. This will enable us to delineate more accurately the production, circulation, and diffusion of ceramics in relation to their discovery locations, chronological framework, and intended functions.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent Tutor*

Prof. Paola Petrosino

Other Proponents (Co-Tutor)

Dr. Lucia Pappalardo, Dr. Danilo Galluzzo

Research Areas (Max. 3):*

1. Volcanology and Physical Volcanology
2. Petrography and Petrology

Main ERC Sector

PE10_5 Geology, tectonics, volcanology

Subject/Title of the scientific project idea *

Thermo-Mechanical Regulation of Fluid Transfer in the Somma-Vesuvio volcanic system: Evidence from Experimental and Petrological Data

Research proposal (max 200 words)

The project aims to investigate the processes that facilitate the transfer of magmatic fluids from deep reservoirs to shallower levels within the Somma–Vesuvius volcanic system, with the broader objective of understanding how such processes can be detected through geophysical monitoring signals. Petrological evidence suggests the presence of a deep feeding system in which interactions among magma, fluids, and carbonate rocks in the substratum significantly modify the physical and mechanical properties of the host lithologies.

In this framework, low-frequency deep seismicity may represent a key indicator of processes occurring at the base of the volcanic system. These rare but distinctive events, which differ from typical volcano-tectonic seismicity, are thought to reflect rupture conditions within a hot, fractured medium that becomes progressively less brittle. Variations in their occurrence rate, spectral characteristics, or hypocentral depth may signal enhanced upward migration of fluids or magma.

To test this hypothesis, deformation and fracturing experiments will be conducted on carbonate rock samples representative of the Vesuvian substratum under controlled pressure conditions and variable temperatures simulating magma ascent. These experiments will be performed using X-ray microtomography, enabling three-dimensional observation of the evolution of rock texture, porosity, fracture networks, and internal damage.

By integrating experimental results with microstructural observations and natural low-frequency seismic signals, the project aims to assess whether progressively heated and more ductile rocks can generate slow, low-frequency fracturing. Ultimately, this approach will contribute to improving the volcanological interpretation of precursory signals at Vesuvius.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent (Tutor)*

Prof. Piegari

Other Proponent(s) (Co-Tutor)

Prof. Camanni

Research Area(s) (Max. 3):*

1. Earthquake forecasting and seismic hazard
2. Tectonics, Structural Geology and related Hazards

Main ERC Sector

PE10_7 Physics of earth's interior, seismology, volcanology

Subject/Title of the scientific project idea *

Maximizing information extraction from seismic catalogs through machine learning: 3D fault geometry reconstruction and interactions for seismic hazard assessment

Research proposal (max 200 words)

This project proposes a quantitative framework based on statistical seismology and unsupervised learning to maximize information extraction regarding fault geometry reconstruction and kinematics from extensive seismic catalogs. The objective is to overcome traditional interpretative limitations by analyzing the three-dimensional distribution and temporal evolution of earthquake hypocenter clouds. Through the development and application of spatiotemporal clustering algorithms, the research primarily aims to: i) illuminate the hierarchical segmentation and structural heterogeneity of fault systems across various tectonic and volcanic settings; ii) quantify the spatiotemporal variations of key seismological parameters; iii) analyze dynamic interactions between segments and the migration of seismicity and fluids.

Wherever possible, the project will integrate the statistical analysis of catalogs with constraints provided by independent geological and geophysical data. This data-driven approach will enable the objective reconstruction of complex geometries, defining the scaling laws that govern the evolution of fault zones to improve seismic hazard assessment.

ENGLISH

Proponent (Tutor)*

Prof. Francesco Putzolu

Other Proponent(s) (Co-Tutor)

Prof. Nicola Mondillo (DiSTAR-UNINA), Dr. Andrea Dini (IGG-CNR), Prof. Licia Santoro (DST-UNITO)

Research Area(s) (Max. 3):*

1. Mineral Deposits
2. Applied Mineralogy
3. Isotope Geochemistry

Main ERC Sector

PE10_10 Mineralogy, petrology, igneous petrology, metamorphic petrology

Subject/Title of the scientific project idea *

Origin of high-grade (illite-type) volcano-sedimentary Li mineralization

Research proposal (max 200 words)

Volcano-sedimentary (VS) deposits include secondary Li-rich assemblages (clay and boron minerals) that form from the alteration of felsic igneous rocks. In most VS deposits the main ore phase is the Li-smectite hectorite, which can accommodate limited Li amounts, therefore resulting in intermediate-grade (~0.3-0.4 wt% Li) and less attractive resources. Variation of the clay mineralogy from hectorite-to-tainiolite (Li-illite) results in an upgrade of the initial Li concentrations to values >0.6 wt% Li. Illite-type mineralization represents a rare end-member of the VS deposit class, with the best documented case being the Thacker Pass deposit in the McDermitt Caldera (USA). Recent studies inferred that Li-illite forms following circulation of magmatic-hydrothermal fluids sourced by caldera resurgence events; a process able to breakdown early hectorite and form Li-illite at ~300°C. This model has significant implications for exploration of high-grade VS systems as it restricts Li-illite to collapsed caldera-hosted systems, where the Li ore forms proximal to its volcanic source due to influx of exotic Li-rich fluids.

Applicants at this project will be required to submit a project proposal including an analytical workflow aimed at verifying this model or determining alternative genetic processes to be applied to appropriate geological settings.

ENGLISH

Proponent (Tutor)*

Prof. Leopoldo Repola

Other Proponent(s) (Co-Tutor)

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Research Area(s) (Max. 3):*

1. Archaeometry and Cultural Heritage

Main ERC Sector

SH6_1 Archaeology, archaeometry, landscape archaeology

Subject/Title of the scientific project idea *

Digital Cultural Landscapes. 3D Digitization Processes and AI Tools for Modeling Applied to the Management, Analysis, and Visualization of Geospatial Data

Research proposal (max 200 words)

Archaeological sites, the historic fabric of cities, and cultural landscapes as a whole preserve traces of natural events — earthquakes, eruptions, floods, landslides, bradyseism, sea-level changes — in sequences of crisis and mitigation, destruction and reconstruction, and shifting dynamics of resource use.

The project aims to build a methodology for studying the cultural landscape based on the production of digital numerical models, capable of providing a comparative analysis of the events and phenomena that have shaped its transformation and driven ecosystem adaptation. The digitization of geological, biological, archaeological, and architectural contexts will form the core of the database from which to develop, also through the use of artificial intelligence techniques, processes of monitoring, virtual modeling, and simulation, following relational and multiscalar approaches capable of reconstructing causes and effects and envisioning possible scenarios, also in light of ongoing climate change.

Planned activities include: integrated 3D survey (terrestrial laser scanning, drone lidar, photogrammetry, multibeam, sub-bottom profiler, side scan sonar) of emerged and submerged landscapes; new protocols for scanning, monitoring, and data integration, applied to research projects at the Campi Flegrei, Procida, and the site of Ḫattuša (Turkey); development of a GIS platform to manage, analyze, and visualize geospatial data.

ENGLISH

Proponent (Tutor)*

Prof. Giacomo Russo

Other Proponent(s) (Co-Tutor)

Dott.ssa Enza Vitale

Research Area(s) (Max. 3):*

1. Geotechnical Engineering

Main ERC Sector

PE8_3 Civil engineering, maritime/hydraulic engineering, geotechnics, waste treatment

Subject/Title of the scientific project idea *

Experimental Investigation of Conditioning Agent–Clay Interactions for the Reuse of Excavated Materials from Mechanized Tunnelling

Research proposal (max 200 words)

The sustainability of large infrastructure projects strongly depends on the management of raw materials and the reduction of waste generation. In this context, the reuse of excavated soils represents a strategy fully aligned with the principles of the circular economy, as it reduces both the demand for natural borrow materials and the need for disposal sites.

The proposed research aims to assess the potential reuse of fine-grained soils generated during mechanized tunnel excavation using Earth Pressure Balance (EPB) technology. In these operations, the excavated material is mixed with water and conditioning agents, such as surfactants and polymers, whose presence may affect its subsequent reusability. The main objective is to investigate the interactions between anionic and cationic surfactants, polymers, and clay minerals, and to evaluate whether conditioned soils can undergo further treatments allowing their reintegration into the construction cycle.

The experimental programme will involve a multiscale characterization of soil–conditioning agent mixtures through mineralogical, microstructural, physical, and hydro-mechanical testing. The effectiveness of both conventional and innovative binders for the treatment and reuse of conditioned soils will also be assessed. Laboratory findings will be validated through a field trial carried out in collaboration with industry partners, in order to evaluate the evolution of the treated material properties, the durability of its performance, and its practical applicability in infrastructure works.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent (Tutor)*

Prof. Nicola Scafetta

Other Proponent(s) (Co-Tutor)

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Research Area(s) (Max. 3):*

Meteorology, Climatology and Oceanography

Main ERC Sector

PE10_3 Climatology and climate change

Subject/Title of the scientific project idea *

From Global Models to Local Realities: Climate Downscaling and Adaptation Indicators for Vulnerable Countries

Research proposal (max 200 words)

Adaptation and mitigation policies in Low- and Middle-Income Countries (LMICs) often rely on projections derived from global climate models (GCMs), which are characterized by insufficient spatial resolution and a systematic underestimation of local-scale uncertainty. This PhD project is conceived as an internal scientific contribution to the CLIMEQUITY project (Horizon Europe, Call CL5 2025 06 D1 06), which UNINA shares with four pilot sites: Pakistan, Malaysia, Morocco, and Sierra Leone. The candidate will apply advanced statistical techniques to CORDEX/CMIP6 ensembles, integrated with ERA5 reanalyses and local observational datasets, in order to generate high-resolution climate projections for temperature, precipitation, and extreme events with a 2050 horizon. Particular attention will be devoted to the explicit quantification of inter-model uncertainty and to the validation of the results using the available datasets. Building on these projections, the PhD student will develop an original set of physical adaptation indicators, measurable over time — local temperature trends, standardized drought indices, frequency and intensity of extremes — thereby filling a gap acknowledged by the IPCC. The results will directly feed into the multi-scale IAM models developed in CLIMEQUITY's WP6, contributing to anchoring climate-justice policies to the physical realities of the most vulnerable territories.

* Campo obbligatorio / Mandatory field

ENGLISH

Proponent (Tutor)*

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Research Area(s) (Max. 3):*

1. Tectonics, Structural Geology and related Hazards
2. Geophysical exploration and modelling of natural hazards
3. Volcanology and Physics of Volcanism

Main ERC Sector

PE10_5 Geology, tectonics, volcanology

Subject/Title of the scientific project idea *

Reconstruction of the deep structure of the Campi Flegrei caldera and of the kinematics in space and time of the main volcano-tectonic structures

Research proposal (max 200 words)

The deep structural architecture of the Campi Flegrei caldera and its relationships with tectonics remain poorly defined, despite numerous direct and indirect investigations of a stratigraphic-structural, geochemical, and geophysical nature. Currently, an integrated reconstruction capable of organically relating the available information into a single volcano-structural framework is lacking. The research will be based on the critical collection of literature data and the generation of new structural data, both soil and subsurface, as well as geophysical. Specifically, vintage high-penetration seismic profiles reprocessed in the Gulf of Pozzuoli and adjacent areas will be interpreted to reconstruct the deep geometric structure of the caldera. A specific part of the work will be dedicated to analyzing current seismicity and its relationship with the main volcano-tectonic structures and the architecture of the magma supply system, including through the use of artificial intelligence techniques. The project aims to produce a geometric model of the caldera and a kinematic model of the main structures, with particular attention to the distribution of displacement along the faults, their spatiotemporal evolution, and their potential role in locating eruptive vents. A further objective will be the construction of geologically robust deformation models for the reconstructed structures, in order to assess their seismogenic potential and improve the characterization of the associated seismic-volcanic risk.

* Campo obbligatorio / Mandatory field