Area Affari Generali
Ufficio Ricerca

Specifiche per la pubblicazione del bando di concorso XXXIII ciclo

SCIENZE DELLA TERRA

Tipologia di procedura selezionata: PROCEDURA UNICA

Descrizione del dottorato

descrizione:	Il Corso di Dottorato in Scienze della Terra (SdT) costituisce il terzo livello di formazione universitaria su tematiche di ricerca avanzata inerenti il sistema terra solida-idrosfera-atmosfera. L'obiettivo principale del Corso di Dottorato è formare esperti di alta qualificazione scientifica. Le attività di ricerca che verranno sviluppate durante il corso verteranno su tematiche di punta nell'ambito delle Scienze della Terra, che potranno essere sviluppate sia in ambito nazionale che internazionale. Lo studente di dottorato in Scienze della Terra acquisirà conoscenze specifiche e svilupperà un progetto di ricerca avanzato sulle maggiori tematiche dibattute a livello internazionale in uno dei seguenti ambiti: Geodinamica, Vulcanologia, Ambiente, Territorio, Energia, Risorse, Rischi, Clima. Il Corso di Dottorato in SdT è organizzato nei seguenti due curricula: (1) Geodinamica, Vulcanologia. Lo studente afferente a questo curriculum svilupperà un progetto di ricerca avanzato inerente alle maggiori tematiche dibattute a livello internazionale di Geologia Strutturale, Tettonica, Geofisica, Geodinamica e Vulcanologia. Lo studente approfondirà conoscenze specifiche riguardanti la deformazione e reologia della crosta e litosfera continentale, tettonica regionale, vulcanismo, modellazione di processi tettonici, vulcanici e geodinamici, meccanismi eruttivi, reologia e proprietà fisiche dei magmi. (2) Risorse, Ambiente e Territorio. Lo studente afferente a questo curriculum svilupperà un progetto di ricerca avanzato inerente alle maggiori tematiche dibattute a livello internazionale di Ambiente, Territorio, Energia, Risorse, Rischi, Clima. Lo studente approfondirà conoscenze specifiche riguardanti ricostruzioni paleoclimatiche e paleoambientali, risorse energetiche, (idrocarburi, geotermia), risorse idriche e dissesto idrogeologico, pianificazione e salvaguardia del territorio, geochimica e geochimica ambientale. Il collegio dei docenti è composto da esperti riconosciuti internazionalmente delle discipline menzionate. Nel corso del Dottorato gli studenti lavoreranno nell'ambito della ricerca sia di base sia applicata. Le tesi di dottorato verranno svolte in laboratori altamente qualificati e/o sul terreno in aree del mondo di specifico interesse. Gli studenti di dottorato lavoreranno in un ambiente altamente stimolante caratterizzato da una collaborazione di gruppi di ricerca afferenti a diverse discipline al fine di realizzare una solida base scientifica e professionale per le loro future carriere nei campi della ricerca delle Scienze della Terra. Il percorso formativo del Corso SdT è rivolto a formare professionalità con potenziale sviluppo occupazionale presso società pubbliche e private, nazionali e internazionali e università e centri di ricerca, pubblici e privati, che sviluppano didattica e ricerca avanzata su tematiche inerenti le discipline delle Scienze della Terra.
titolo (ing.):	Earth Sciences
descrizione (ing.):	The PhD program in "Earth Sciences" (SdT) is the third level of university education on topics focused on the cutting-edge research in solid earth-hydrosphere-atmosphere. The main aim of the program is to train experts of high scientific qualification. The research activities that will be developed encompass fundamental Earth sciences disciplines at both national and international levels. The PhD student will acquire specific knowledge and professional skills and will develop a research project on advanced topics, debated in the international community, in Geodynamics, Volcanology, Environment, Climate, Resources, Energy and Geological Risks. The program in "Earth Sciences" is organized in two main

curricula: (1) Geodynamics and Volcanology (2) Resources and Environment. (1) Geodynamics and Volcanology. The student will develop a research project focused on the main topics debated at international levels related to Structural Geology, Tectonics, Geophysics and Volcanology. The student will acquire specific knowledge on the deformation and rheology of the crust and continental lithosphere, regional tectonics, modelling of tectonic, volcanic and geodynamic processes, eruptive dynamics and rheology and physical properties of magma. (2) Resources and Environment. The student will develop a research project focused on the main topics debated at international levels related to Resources, Energy, Environment, Climate and Geological Risks. The student will acquire specific knowledge on the paleo-environment and paleo-climatic reconstructions, energy (hydrocarbons and geothermal energy), hydric resources and hydrogeological risk, territory management, geochemistry and environmental geochemistry and modelling of geological processes. The board of supervisors consists of worldwide recognized experts specialized in the cited disciplines. Within the Ph.D. Course, students will benefit from top-level basic and applied research. Doctoral theses will be carried out in laboratories characterized by multi-disciplinary research approach, and/or field work in selected regions around the world. Ph.D. students will work in a stimulating environment characterized by a strong integration and cooperation among different Earth science disciplines, building up a strong background for their future career in Earth science research fields. The Ph.D. program aims at creating professional figures in public institutions and private companies, national and international and in universities and research centers devoted to research and education in Earth science.

Procedure attivate

PROCEDURA STANDARD	SI (OBBLIGATORIA)
PROCEDURA RISERVATA PER STRANIERI	SI
PROCEDURA RISERVATA PER BORSISTI ESTERI	NO

Procedura standard

Specifiche economiche

Specifiche economiche complessive per il corso contenute nella richiesta di accreditamento

Borse Ateneo	Borse Dipartimento	Borse Esterne	Posti senza borsa	Borse Riservate
7	1	0	2	1

Tematiche definite per il dottorato

- Study of natural manganese oxides as environmental indicators and their role in the spreading of toxic elements

Scientific problem: Despite several studies performed on these minerals, literature data are often conflicting; indeed, Mn-oxides are very difficult to study and characterize because they are commonly found as disordered and cryptocrystalline nano-materials, often finely intermixed with other minerals such as Fe-oxides/hydroxides, calcite, quartz and clay minerals. All these limitations do not allow to fully understand their role in the environment, as removal or spreading factor of potentially toxic elements and they pose serious limitations in paleo-climatic and also geo-archaeological studies. Research topic: The topic of this study are the natural Mn-oxides, their structure and the structural changes that easily occur when changing the environmental conditions (T, pH, Eh), and provide tools to overcome the limitations that have conditioned and limited research in this field. Aims: This research aims to develop a multi-methodological analytical protocol to study natural Mn-oxides. All these data will be used in: i) characterization of pigments in pottery, frescos, illuminated manuscripts, stained glass and cave paintings; ii) to better understand the role of Mn-oxides in the environmental spreading of potentially toxic elements, such as arsenic and heavy metals; iii) paleo-environmental reconstructions and iv) create databases of IR, Raman spectra and spectral signatures of very well characterized Mn-Ox phases for remote sensing applications. Finally, to provide tools for understanding of past environmental conditions on

Mars. Methods: The research is based on a multidisciplinary approach by crossing data from several different techniques such as: SEM, TEM, XRPD, FT-IR and Raman (vibrational spectroscopy), XANES and EXAFS (X-ray spectroscopy), magnetic properties. In addition, on some well characterized phases, experiments under non-ambiental conditions will be carried out to study the stability of these phases with T, pH, and Eh. Educational objectives: The project is aimed at students with a strong mineralogical background, who are familiar with the techniques employed, especially in their application to cryptocrystalline materials. This Ph.D. project offers the opportunity to acquire skills on advanced analytical techniques and on the characterization and the study of the properties of nanomaterials. The PhD student is also required to follow high-level courses and seminars and to attend international conferences on arguments concerning the topic of this research.

- Study of natural manganese oxides as environmental indicators and their role in the spreading of toxic elements

- Pressure-Temperature-time-deformation (P-T-t-d) history of the Alpine orogeny in the internal zone of the Rif belt (Northern Morocco).

Research topic: The research proposal is intended to contribute to constrain rates and processes associated with orogenic construction in collisional and accretionary orogens by studying units deformed in the transition from the anchizone to the subduction-zone metamorphism. The nappe edifice exposed in the inner Rif belt of Northern Morocco provides an ideal case study to achieve this purpose across a structural transect running from the internal Dorsale Calcaire units and their detached basement to the low-grade Federico tectonic slices (Tizgarine and Boquette units, in particular). The PhD study will be then devoted to define first the P-T-t-d evolution of the main tectono-stratigraphic units and then the paleo-geothermal regimes and rates of tectonic processes during orogenic construction at the scale of the belt. Aims: The primary aim of this PhD study is to use field and laboratory studies to reconstruct the tectono-metamorphic history (P-T-t-d paths) of the low-grade units that make up the core of the low-grade tectonic slices exposed in the inner Rif belt. Specific aims are: (i) the reconstruction of tectonic vergence during the Alpine orogenic construction; (ii) the assessment of the timing of orogenic construction; (iii) the definition of the character/origin/significance of the tectonic coupling between the low-grade and high-grade tectonics units that make up the core of the Rif orogen (Alboran Domain); and (iv) tectonic correlations at regional scale in the frame of the Alpine geodynamics of the western Mediterranean. Methods: The research rationale is based on a multidisciplinary approach that combines field work and structural investigations at the meso- and micro-scale with laboratory work, functional to reconstruct the P-T-t-d evolution of orogenic terranes. Field studies will be carried out in selected areas along the internal Rif belt and will be mainly devoted to the characterisation of the structural (ductile and brittle) architecture of the study areas, to map the major tectonic boundaries among the exposed tectonic units, and to sample representative lithologies for laboratory work. Laboratory work will include: (i) geochemical analyses (whole rock composition, fluid geochemistry and microtermometry); (ii) organic petrography and Raman spectroscopy characterisation of the carbon-rich units; (iii) petrological studies (textural studies and metamorphic thermobarometry); (iv) geochronological studies (40Ar/39Ar technique to be carried out both in situ and on mineral separates); (v) low-temperature thermochronological studies (AFT and AHe dating techniques); Educational objectives: The project would suit a student with a strong background in structural geology, field and laboratory work. A continuous training on methods and techniques for the study of low-grade metamorphic rocks will be provided, offering the possibility to acquire, in particular, skills to reconstruct the P-T-t-d history in orogenic environments. Training will take place both at Roma Tre as well as in foreign research institutions collaborating to the project.

- Pressure-Temperature-time-deformation (P-T-t-d) history of the Alpine orogeny in the internal zone of the Rif belt (Northern Morocco).

- Age and provenance of the Cenozoic Numidian Flysch in Morocco and Sicily: the biostratigraphic and sedimentologic input to the definition of the western Mediterranean palaeogeography

Scientific problem: Despite several studies were performed on the Numidian Flysch, the provenance and the age of this formation, crucial to understand the basin context of this part of the alpine chain, is still debated. References to the age of Sicily and Morocco Numidian deposits are very scarce and come from qualitative biostratigraphic analyses. According to the authors, in Sicily the age spans from early Aquitanian to late Burdigalian (Hoyez, 1989; Guerrera et al.,1992; De Capoa et al., 2004; De Capoa et al., 2007), and in Morocco from early Chattian to middle Burdigalian (Durand Delga et al.,1985; De Capoa, 2007). However, recent analyses, performed in our Department, highlight a possible younger age for the Moroccan deposits. Furthermore, even if most of the authors agree to refer the origin of the Numidian Flysch to the Africa craton (e.g. Thomas et al., 2010 and reference therein), detailed age of the Maghrebian Numidian sequence in both Sicily and Rif belts is until now lacking, besides sedimentology, sediment-routing system and their deposition integrated within a source-to-sink approach remain an open way in modern earth science research. Research topic: Age and provenance definition of the Numidian Flysch cropping out in Sicily and Morocco sections: being part of an Alpine fold-and-thrust-belt, it is complicated but fundamental to reconstruct the relationship with the substratum of the Numidian Flysch and, consequently, its palaeogeographic position. There is debate on the mixed nature of the numidian deposits: an open question is understanding if they represent contemporaneous turbidite systems sourced from different areas or switches in sediment type from a single source region. Finally, since the source of Numidian Flysch is debated, the question regarding its geodynamic implication remains unsolved: does it represent a foreland basin filled by sediments coming from the alpine thrust-belt (De Celles &Giles, 1996), or by sediments coming from an uplifted foreland/forebulge domain? Did the Numidian Flysch result from a mixed mode provenance from both the alpine thrust-belt and cratonic and Paleozoic source areas? Aims: The project aims to provide both a reliable chronostratigraphy for the Sicilian and Moroccan Numidian Flysch deposits and a defined sedimentological overview pointing to the characterization of their architecture and to the comprehension of gravity flows provenance. As a consequence, a correlation between the Sicilian and Moroccan deposits is expected. Finally, a constraint to the palaeogeographical position of the Numidian Flysch deposits is awaited. According to the expected results, new insights for defining this foreland basin character in terms of

uplifted feeding sources able to provide sediments might be a secondary outcome. Methods: • Sedimentary field analysis through the composition and sampling of appropriately selected stratigraphic sections. • Quantitative biostratigraphical analysis of the calcareous nannofossil assemblage. • Zircon U/Pb dating to accurate modal analysis and to well constraint the provenance and source region Educational objectives: This PhD project points to train the student both on Neogene biostratigraphy and on sedimentary evolution of the gravity flows deposits and related depositional systems in order to become an autonomous and active researcher on these topics. Furthermore, it is desirable to form a scientist able to face complex topics (e.g. dating flysch deposits, determining their provenance and defining the basin within its specific geodynamical context) through a multidisciplinary approach.

- Age and provenance of the Cenozoic Numidian Flysch in Morocco and Sicily: the biostratigraphic and sedimentologic input to the definition of the western Mediterranean palaeogeography

- An improved seismic model of the upper mantle below the Tyrrhenian Sea: implications for current thermo-chemical conditions and geodynamical evolution

Scientific problem: The evolution of back-arc basins is strictly linked to the subduction-zone dynamics. The Tyrrhenian Sea presents several peculiar features and, in spite of its vicinity to the Italian peninsula, its deep structure remains unexplored. Understanding the complex geodynamic evolution of the Tyrrhenian Sea is fundamental to shed light on the evolution of the Mediterranean Sea and, more in general, to improve knowledge of back-arc basins dynamics. Research topic: The Tyrrhenian Sea is an asymmetric back-arc basin that presents both arc volcanism (Aeolian islands) and several extinct (e.g., Vavilov) and active (e.g., Marsili, Palinuro) volcanoes in extensional regions. Recent oceanographic cruises studied the shallow part of these structures, evidencing, among other things, a high tsunami risk, but the portion of the upper mantle from 50 to 200 km of depth (and beyond) below the Tyrrhenian Sea remains largely unexplored. Due to poor coverage of oceanic regions and to the lack of stations in Sardinia, current surface-wave models (e.g. Greve et al. 2014) are characterized by low resolution. Teleseismic and regional travel-times tomography of the southern- Tyrrhenian Sea are able to well resolve the subduction zone (e.g., Piromallo et al. 2003, Chiarabba et al. 2008, Calò et al. 2013), but do not provide an adequate coverage of the Tyrrhenian Sea upper mantle. In addition, they only give information on relative velocities, while absolute velocities are essential for interpretation. On continental scale, models of absolute VS including a variety of seismic dataset have been recently built (e.g., Savani -Auer et al. 2013, EU60 - Zhu et al. 2013), but they have still limited resolution for what concerns the Tyrrhenian Sea. So far, the picture that has emerged associates the recent extensional volcanism in the Tyrrhenian Sea with rapid retreating and mantle upwelling probably connected to a slab tear imaged in the Calabrian arc (Wortel &Spakman 2000, Faccenna et al. 2001, 2004, Peccerillo &Frezzotti 2015, Chiarabba &Palano 2017). In any case, the exact nature of the mantle below the Tyrrhenian Sea remains unknown. Aims: The proposed research aims to improve the seismic images of the entire upper mantle for both shear waves (VS) and compressional waves (VP) and, consequently, evaluate with unprecedented resolution, the current temperature and compositional conditions, including the effect of hydrous compositions. The results will be interpreted in the context of the geodynamic evolution that will be compared to other back-arc basins. The new seismic model could potentially clarify several aspects of the complex interaction between the subduction zone and the opening of the Tyrrhenian Sea (which includes the active volcanism) and thus obtain a new insight on the deep water cycle. Methods: A vast range of seismic data is available for this project. Those include previous compiled datasets used for previous models and the new data for the seismic stations of the LISARD project. The new data will allow to significantly increase the coverage of the Tyrrhenian Sea (Fig. 1). For instance, the entire Central-Italy sequence, but also the relatively large events in Switzerland and the deep (~500 km) event in the Tyrrhenian Sea along the subduction slab are well recorded by the array (together with the global activity for MW larger than 5.5). The in-house data will be processed by the PhD student to extract the dispersion curves of surface waves from ambient-noise cross-correlation (Rayleigh and Love phase velocities) and travel times of main P-, S- body waves and surface waves associated with Earthquakes. The surface-waves data will be combined with body-waves and we will run a joint VP-VS inversion following the procedure used for SPAni (Tesoniero et al. 2015). To note that the model will give also an insight on the seismic anisotropy, which is required in order to satisfy both Rayleigh and Love waves. The interpretation of VS/VP anomalies and of the absolute velocities for temperature and composition (including hydrous compositions) will be performed on the basis of mineral physics data. The obtained results will be put in the context of the proposed geodynamic scenarios and compared with the results of other back-arc basins. Educational objectives: The PhD student will be involved in all steps of this study, from raw-data processing of seismic data to tomography elaboration and its interpretation. This will give him/her the opportunity to acquire a broad range of skills that encompass the purely seismological ones, a good knowledge of Mediterranean geodynamics and evolution of back-arc basins more in general. In addition, the international collaborations will give the student the opportunity to face and to work in different working environments.

- An improved seismic model of the upper mantle below the Tyrrhenian Sea: implications for current thermo-chemical conditions and geodynamical evolution

- HT stability, deprotonation mechanisms and physical properties of Fe-bearing amphiboles

Mineral reactions of hydrous materials at HT involve the loss and migration/diffusion of oxygen/hydrogen molecular species. These processes are typically associated with simultaneous oxidation of multi-valence elements, such as Fe or Mn, with significant consequences on the physical properties, such as the electrical conductivity or magnetic properties, of the material. For rock-forming minerals, a notable case is represented by amphiboles. Fe-dominant sodic amphiboles ("crocidolites") were diffusively studied at HT during the 1960-1970's, because of the emerging technological applications of these materials. The dehydration mechanism was characterized in its general features during these early studies, however the structural adjustments accompanying the oxidation of iron and the loss of hydrogen were addressed later. Despite this large amount of work, however, notable issues still need to be understood, including the mechanisms and kinetics of proton diffusion throughout the mineral matrix, and the role of Fe in this process. Advancements in this topic were later presented by Oberti et al. (2016) and Della Ventura et al. (2017); by combining the X-ray diffraction and spectroscopic methods (FTIR, Raman), these authors were able to demonstrate how the whole process occurs at the

crystal surface and implies a fast diffusion of both protons and electrons across the mineral matrix. This point is particularly important for the bearings in geophysics, considering the well-known increase in electrical conductivity of amphibole-rich rocks subducted at convergent margins in tectonically active areas. The PhD project proposed here aims at: (1) defining the role of the different amphibole chemistries on the HT behaviour, and, in particular, their deprotonation mechanism; (2) synthesize selected compositions under controlled P(H2O) and T conditions, for further studies at high-T. The use of synthetic counterparts is believed to significantly reduce the experimental uncertainties for the data interpretation; (3) Develop new spectroscopic techniques to characterize in situ the evolution of the amphibole chemistry, and in particular of the Fe2+/Fe3+ ratio as a function of increasing T. (4) Develop novel methods to characterize in situ the evolution of the electric and magnetic properties of the samples. (4) Develop industrial partnerships due to the possible technological applications of these materials. The project will be conducted in collaboration with the INFN (Frascati) and the INGV (Rome), and several international laboratories such as the Institut für Mineralogie und Kristallografie, Universitat Salzburg (Austria), and the Mineralogisch-Petrographisches Institut, Universität Hamburg (Germany), as well as large-scale facilities such as Diamond Light Source (DLS), Oxford (UK), the Helmholtz Zentrum (Berlin) and Elettra (TS). The project will involve the use of several frontier methodologies, such as HT-spectroscopies (FTIR, Raman), HT-XAS and diffraction and Mössbauer.

- HT stability, deprotonation mechanisms and physical properties of Fe-bearing amphiboles

- The post-orogenic deposits of the Simbruini-Ernici range in the framework of the Plio-Quaternary evolution of the Central Apennines

Scientific problem: In the Simbruini-Ernici range, continental deposits, mainly carbonate in composition, are related to numerous sedimentary cycles, which record the sin- and post-orogenic morpho-tectonic evolution of this sector of the Central Apennines. These deposits are still poorly defined from the morphological, chronological, stratigraphic, paleo-environmental and structural point of view. This indeterminacy is due to the absence of recent and detailed studies on the area and on the objective difficulty in dating most of the outcropping deposits of the area. In particular, still open scientific issues concern the following aspects: a) is it possible to define the age and the tectono-stratigraphic evolution of the post-orogenic clastic continental deposits of the Simbruini-Ernici mountain range? b) is it possible to apply innovative radiometric dating techniques to carbonate clastic deposits, which form such a significant part of the Apennines Chain? c) is it possible to define the age of extensional tectonics and of the uplift processes of this sector of the chain and to better define the post-orogenic evolution of the Central Apennine chain? Research topic: the Simbruini-Ernici range represents one of the main morphotectonic structures of the Central Apennines. The structural architecture and the phases of orogenic deformation have been detailed my means of deep wells, and by structural and stratigraphic studies which have allowed the reconstruction of the tectonic and stratigraphic evolution of the chain-foredeep system in this sector of the Central Apennines. Conversely, the post orogenic evolution of this sector of the chain is poorly constrained. In fact, the Simbruini-Ernici range, differently from other sector of the Central Apennines, lacks well defined intermountain basins, and the post-orogenic history of the chain is recorded by several sedimentary cycles of clastic deposits, mainly carbonate, which are substantially undated up to now. To find out a useful methodology to date these deposits and to understand the stratigraphy and the morphotectonic evolution of this sector of the Central Apennines are the main research topic of the PHD proposal. Aims: The aim of the research is to address the following two aspects: a) definition of morphotectonic and depositional processes related to the extensional tectonics of the area and its framing in the regional evolution of the Central Apennines; b) verification of the applicability of U/Pb dating techniques on carbonate deposits that can provide the indispensable chronological constraints to the evolution of the area. Methods: The study of the evolution of the post-orogenic deposits of the Simbruini-Ernici mountain range will be based on a multidisciplinary approach that includes: • topographic analysis (statistical analysis of relief, residual topography, swath profiles, etc); • study of the drainage reorganization (evidence of watersheds migration, plano-altimetric distribution of wind gaps and water gaps). • morphometric and sedimentological analyses of alluvial deposits and identification of paleo-flow directions, feeding areas, etc.); • dating of clastic deposits, using paleomagnetic and radiometric techniques (U/Pb); • reconstruction of the morphologic evolution of the area using the plano-altimetric distribution of the geomorphological markers. Educational objectives: Throughout the three years of PhD, training can take place both within the Department of Science of Rome Tre, and in other Italian and foreign scientific organizations, by taking part in high-level courses and seminars. It is planned that the partial results of doctoral research will be presented at national and international congresses. During the PHD thesis stays and internships are also planned at laboratories and research institutions abroad. Radiometric analyses will be carried out in collaboration with the University of Portsmouth, which has a special experience in applying U/Pb dating to continental carbonate deposits.

- The post-orogenic deposits of the Simbruini-Ernici range in the framework of the Plio-Quaternary evolution of the Central Apennines

- Surface Fingerprints of Earth dynamics: modelling the coupling between tectonic and surface processes

Scientific problem: Coupled, fully dynamic models is still poorly developed and limited in their ability to directly predict deformation, uplift and topography at the scale of observation in specific settings. This is primarily due to the strong non-linearity inherent to crustal faulting and surface processes. There is thus a mismatch between the scale at which geodynamic models can make predictions and the scale at which we make observations of topography and crustal deformation. Filling this gap is a first order research opportunity for a PhD thesis. Aims: The overarching goal of the project is to develop a new class of models capable of predicting surface characteristics (topography, uplift, strain, landscape evolution) at a scale suitable for direct comparison to field observations. The aim is to build a suite of dynamic, crust and surface models using both numerical and analogue techniques and apply these tools to investigate parameter sensitivity, and search for undiscovered, emergent phenomena. The model will be compared to features observed on specific sites, natural laboratories, as Apennines or Alps, eastern Cordillera (Colombia). Methods: The approach includes development of models, with the aim to quantify the connection between mantle, crustal and surface processes. Analogue and numerical approaches are complementary for idealized, process-based models, and a combined approach

has proven powerful to understand the inherent imitations in each. In addition, analogue models naturally capture the role of three-dimensionality and problematic boundary conditions (e.g., free surface). Modelling will serve both for identification of important processes and parameters and for detailed studies, tailored to specific regional settings, including the dynamic contribution to topography. Analogue modeling. A novel experimental methodology will be launched at the Laboratory of Experimental Tectonics (LET) of Roma TRE to simulate a fully coupled mantle-lithosphere-surface system, including surface erosion. To date, surface erosion has been treated in analogue models by sprinkling water microdroplets over various granular materials (e.g., Lague et al., 2003; Gravelau et al., 2011), and mantle convection has been widely reproduced by tank experiments using syrups (Funiciello et al., 2006), but these two processes have never been merged together. Pilot experiments at LET simulate, for the first time, the coupling between deep and surface processes, where erosion is treated as a diffusive process (Kiraly et al., 2014). The aim of this new class of models will be to develop on surface true hillslope and channel erosion occurring on top of a visco/elastic lithosphere-mantle system. The proposed experimental work will be performed in three phases: preliminary rheological study with the goal of selecting and calibrating the proper materials. The LET hosts comprehensive facilities to characterize the rheological signature of viscous and visco-elastic materials (i.e., rheometer; viscosimeter; densimeter). In the second phase, a new apparatus will be built which will permit 3D, dynamically self-consistent, time-scaled models with surface and convective processes. The experimental monitoring will be performed by means of a 3D laser scan and high-resolution still- and video-cameras. A full parameter exploration approach will be adopted in the third phase to study the influence of different factors (e.g., rheological profile, boundary conditions, tectonic setting) in affecting surface topography. Numerical modelling. High resolution lithosphere scale modelling will also be conducted using I3(EL)VIS. The emphasis here will be on coupling to surface processes. Pilot studies by our co-tutor member at ETHZ (Ueda, Gerya and Willett) show that I3(EL)VIS can be coupled with the surface process model DAC and will be available for investigation of coupled processes in various scenarios including forcing by underlying mantle flow in order to produce a true core to atmosphere model. Expected result: Patterns of surface evolution related to the deformation of the Earth's lithosphere and mantle, with identification of coupling and feedback for specific geodynamic processes. These will be used to identify and catalogue specific topographic signature. Model result will be compared to natural examples such as Apennines, Alps, Eastern Cordillera (Colombia). Educational objectives: This proposed approach is based on synergistic interactions between observationalists and modellers. The candidate will have the possibility to merge the two approaches spending long periods at ETHZ Zurich, which is recognized worldwide as a leading research centre. The multidisciplinary approach will bring together new advances on computational advances in surface process modelling. The PhD will be able to learn computational methods and material rheology. Those two fields are certainly very attractive for the post-Phd scientific or industrial career of the candidate

- Surface Fingerprints of Earth dynamics: modelling the coupling between tectonic and surface processes

- Fragmentation criteria for viscous magma

Scientific problem: Explosive volcanic activity can take a wide range of forms, ranging from Hawaiian fire fountaining and Strombolian eruptions to highly energetic Vulcanian and Plinian eruptions. In low-viscosity magmas, bubbles can easily expand, ascend and coalesce, so that proposed fragmentation mechanisms include bursting bubbles and foam instability. In high viscosity magmas it is thought that fragmentation can occur through two primary mechanisms: rapid acceleration or rapid decompression of magma. Rapid decompression is a likely trigger for fragmentation and explosive activity in situations where there is a rapid reduction of confining stress on the magma, or when bubble overpressure is built. Rapid acceleration is promoted when vesiculation due to exsolution of gas from rising magma is delayed until a high degree of supersaturation is reached. Rapid exsolution then causes the development and rapid acceleration of a magmatic foam. Rapid acceleration results in high strain rates which induce stresses across the bubble walls sufficient to cause brittle failure and fragmentation. Rapid acceleration is considered to be the more likely cause of fragmentation in Hawaiian and many Plinian eruptions, whereas rapid decompression has been considered as a likely mechanisms in cases of both rapid decompression (lava dome collapses or during slope failure such as that which triggered the initial lateral blast during the May 1980 eruption at Mount St Helens) and of sustained plinian activity (viscosity quench). In both cases, a transition from ductile to brittle behaviour of the magma is expected. Brittle failure can occur whenever the tensile, compressive or shear strength of magma is overcome, by decompression or by acceleration. There is an unusual small number of strength studies in literature with reported values varying of several orders of magnitude. Moreover, no systematic work has ever been performed to understand and parameterize the strength (tensile, compressive and shear) of multiphase natural magma as a function of its physical state and therefore to quantify the conditions for brittle failure. Research topic: This study will explore in detail the fragmentation process underlying explosive eruptions. Quantification of the strength of magma will be achieved using different experimental techniques which explore different fragmentation processes: decompression, where fragmentation is achieved by the sudden release of high-pressure gas; acceleration, where the shear strength of magma is overcome. The effect of different anhydrous chemistry, of bubbles and crystals content, and of the bubble/crystal size distribution and shape on the strength of magma will be explored. Experimental materials (pre-run and post-run) will be texturally characterized in terms of vesicolarity, crystallinity (VSD, CSD) and dissolved volatile content. Textural analyses will allow the study of viscous/brittle transitions by the analysis of strain partitioning and permeability development. Based on the combined studies, the project aims to provide constitutive equations for multiphase strength of natural magmas (tensile, compressive and shear) taking into account the effects of volatiles, crystals and bubbles on the magma dynamics. Numerical simulation of conduit dynamics will be performed in order to understand the magmatic fragmentations under different regimes (decompression versus acceleration) for mafic and acidic high-energy eruptions. Results will be applied to key studies. Aims: The aim of the project is to understand how the physical state of magma (anhydrous chemical composition, volatile content, bubble and crystal content and shape) can influence the strength of magma (tensile, compressive or shear strength) and to relate this to the type and energy of fragmentation and therefore to the intensity of mafic and acidic eruptive activity. Methods: Different experimental techniques will be used: Decompression experiments (tensile strength) will be performed in an apparatus based on the shock-tube principles (LMU Munich). Compressive and shear strength will be investigated using the uniaxial press in different operational modes at the EVPLab at the University of Roma Tre. Textural analyses will be

conducted using both 2D (optical and electronic microscope) and 3D (x-ray tomography) techniques. The microtomographic analysis will be performed at the SYRMEP beamline of the Elettra synchrotron radiation facility in Basovizza (Trieste, Italy). X-ray computed microtomographic (micro-CT) techniques, based on synchrotron radiation sources, produce three-dimensional (3D) images of the internal structure of objects with a spatial resolution at the micro- and submicro- scale. The use of this new methodology will permit to accurately reconstruct the real crystal and vesicle textures present in experimental specimens and to overcome the stereological limitations arising using only 2D techniques. Educational objectives: The project would suit a student with a strong background in physical volcanology and interests in laboratory, experimental and numerical work. Training on methods and techniques for the study of magma physical and chemical properties will be given by the Laboratory of Experimental Volcanology and Petrology at the University of Roma Tre. The student will acquire good knowledge and skills on textural, petrological and geochemical analyses. Training will also be achieved through participation to high-level courses and seminars. Presentation of the results of the doctoral research at national and international congresses will also be part of the educational process
- Fragmentation criteria for viscous magma
Il candidato sceglierà una tematica in fase di presentazione della candidatura on line

Procedura concorsuale

Valutazione titoli	La valutazione dei titoli riguarda il percorso formativo universitario, nonché gli eventuali ulteriori percorsi formativi ed esperienze professionali e di ricerca e le eventuali pubblicazioni scientifiche. La valutazione è in trentesimi
Prova orale	La Commissione Giudicatrice valuterà l'attitudine alla ricerca di ogni singolo candidato ammesso a sostenere la prova orale. Oltre a domande specifiche inerenti la tematica di ricerca per la quale il candidato ha presentato domanda, verranno discussi il progetto di ricerca e i titoli presentati.

Informazioni e recapiti	The Secretariat email: dottorato.scienze@uniroma3.it
Eventuali ulteriori informazioni	http://www.scienze.uniroma3.it/phd/3/test

Curriculum studiorum

data e voto di laurea (obbligatorio)
elenco degli esami sostenuti per la laurea **MAGISTRALE** e relative votazioni (obbligatorio)
elenco degli esami sostenuti per la laurea **TRIENNALE** e relative votazioni
elenco cronologico di Borse di studio, Assegni di ricerca (et similia) percepiti
Diplomi/certificati di conoscenza lingue estere
Diplomi/attestati di partecipazione di corsi universitari post-lauream
Attestati di partecipazione a gruppi di ricerca
Attestati di partecipazione a stage
Altri riconoscimenti (p. es.: premiazione in concorsi, seconda laurea)

Ulteriore documentazione richiesta ai candidati

progetto di ricerca	Obbligatorio
prima lettera di presentazione (a cura di un docente)	Obbligatorio
seconda lettera di presentazione (a cura di un docente)	Obbligatorio
terza lettera di presentazione (a cura di un docente)	Obbligatorio
elenco delle pubblicazioni	Non obbligatorio
descrizione delle precedenti esperienze di ricerca	Non obbligatorio
lettera di motivazione (a cura del candidato)	Obbligatorio

Competenza linguistica richiesta ai candidati

Il candidato dovrà obbligatoriamente conoscere le seguenti lingue:
INGLESE

Procedura riservata per stranieri

Procedura concorsuale

Valutazione titoli	The evaluation of candidates will be based on: 1) (mandatory) university (or equivalent) degree; 2)(mandatory) abstract of the final thesis; 3)(mandatory) list of passed examinations (with scores); 4) (mandatory) curriculum vitae et studiorum; 5)(mandatory) a proposed research project; 6) (mandatory) at least three reference letters provided and signed by relevant members of the international scientific community, relating to the candidate's choosen course.7) list of pubblications;8) (mandatory) motivation letter .
Prova orale	After preliminary evaluation of the titles, the Committee may, if considered necessary, contact the eligible candidate(s) by e-mail for a possible oral interview by Skype.

Informazioni e recapiti	The Secretariat email: dottorato.scienze@uniroma3.it
Eventuali ulteriori informazioni	http://www.scienze.uniroma3.it/phd/3/test

Curriculum studiorum

data e voto di laurea (obbligatorio)
elenco cronologico di Borse di studio, Assegni di ricerca (et similia) percepiti
Diplomi/certificati di conoscenza lingue estere
Diplomi/attestati di partecipazione di corsi universitari post-lauream
Attestati di partecipazione a gruppi di ricerca
Attestati di partecipazione a stage
Altri riconoscimenti (p. es.: premiazione in concorsi, seconda laurea)

Ulteriore documentazione richiesta ai candidati

progetto di ricerca	Obbligatorio
abstract tesi di laurea	Obbligatorio
prima lettera di presentazione (a cura di un docente)	Obbligatorio
seconda lettera di presentazione (a cura di un docente)	Obbligatorio
terza lettera di presentazione (a cura di un docente)	Obbligatorio
elenco delle pubblicazioni	Non obbligatorio
descrizione delle precedenti esperienze di ricerca	Non obbligatorio
lettera di motivazione (a cura del candidato)	Obbligatorio

Competenza linguistica richiesta ai candidati

Il candidato dovrà obbligatoriamente conoscere le seguenti lingue:
INGLESE

Roma, 13/6/2017

BARBARA NORRITO