



Modèle de projet de thèse – CD internationaux UP 2020

Ecole doctorale (préciser le numéro) :

École Doctorale 560 STEP'UP (Sciences de la Terre et de l'Environnement et Physique de l'Univers de Paris)

Titre du projet :

PHYSICAL GEOCHEMISTRY OF A VOLCANIC ISLAND HYDROTHERMAL SYSTEM (GUADELOUPE, LESSER ANTILLES): SOURCES, DYNAMICS AND PRECURSORS OF VOLCANIC ACTIVITY

Structure d'accueil principale :

Institut de Physique du Globe de Paris, 1 rue Jussieu 75238 Paris
Observatoire Volcanologique et Sismologique de Guadeloupe – Gourbeyre (F)
Equipe « Systèmes Volcaniques »

Structure d'accueil secondaire :

Dept Earth and Planetary Sciences, University of New Mexico

Directeur de thèse pressenti:

Nom : MORETTI Prénom : Roberto
Adresse électronique : moretti@ipgp.fr
Co-directeur·ice de thèse pressenti·e (le cas échéant) à définir et/ou voir en bas (T. Fischer)

Encadrant·e dans la structure d'accueil secondaire

Nom : FISCHER Prénom : TOBIAS
Adresse électronique : fischer@unm.edu



Description du projet de thèse (2 pages maximum)

Hydrothermal systems in volcanic environments are complex systems embracing the dramatic thermal, baric and chemical changes occurring from depth, where one or more magmatic chambers are located, up to surface, where fluid emissions (fumaroles, plumes, hot springs, soil gases) are observed and characterized.

Given their nature, particularly their chemical richness related to the igneous environment, hydrothermal systems in volcanic arc islands represents one of most challenging objects for geochemical modelling of occurring fluid-mineral equilibria. Nevertheless, for these same reasons such systems are also an invaluable source to study how acid-base and redox exchanges (briefly, fluid-mineral interactions) take place and shift from depth to surface, thus generating precursors of volcanic activity and providing unique information to map and quantify the potential for high-temperature geothermal exploration and exploitation.

The objective of this ambitious PhD project is to carry out field and computational activity in order to constrain and model the **full evolution**, the **geothermal potential** and the **dynamic response** of the hydrothermal system of a major andesitic volcano (La Soufrière of Guadeloupe, French West Indies). and its surrounding areas.

This PhD project aims at 1) creating a geochemical database for the hydrothermal fluids of La Soufrière and surrounding areas e La Soufrière de Guadeloupe, 2) exploiting the database at its best and extract the thermochemical informations by performing a full geochemical inversion based on the modeling of magmatic fluid « scrubbing » and « gas-water-rock interaction » (p.e., Symonds et al., 2001), by using the reaction path modelling techniques, with adoption of local equilibrium conditions.

Established collaborations with the regional BRGM division (Ywenn de La Torre), the local Departmental Water Bureau (Laure Ducreux) and the ORMAT geothermal power plant in Bouillante (Bernard Hira) will allow assembling a homogenous fluid database including the more than 20-year long geochemical database on fumarolic gas and spring water provided by the Volcanological Observatory (OVSG).

The la Soufrière *unrest* taking place since 1992 and evolving to unprecedented phases of activity (see the peak of activity in 2018) offers to this project a unique opportunity to develop and test new geochemical techniques for high-frequency collection of fumarolic gas data, which will be elaborated in order to track the short-term evolution of the hydrothermal systems and provide evidence for reliable geochemical precursors involving minor redox reactive species (e.g. CO, CH₄, H₂) in addition to major ones. In particular, the student is expected to contribute to the development of the Volcanic Mass Spectrometer (VMS) at the Dept. of Earth and Planetary Sciences of the University of New Mexico University (USA), under the guidance of prof. Tobias Fischer, where the student will spend around 30 % of his/her time before implementing the technique on La Soufrière.

In the last half-year of activity, the student is expected to use the obtained results from the geochemical inverse modelling to provide a set of boundary conditions and constitutive equations entering the THOUGH 2 geothermal simulator with the aim of testing hypotheses about the forcing responsible of gas and heat budgets measured at surface and their variations. This part will be done in cooperation with Marina Ross-Carbajal (IPGP-CNRS)



The introduction of results from geochemical modelling, particularly of fluid-mineral equilibria to constrain P-T-depth paths of the thermo-fluid-dynamic set of solutions resulting from THOUGH2 simulations will be a highly innovative implementation leading to the comprehension of the dynamic response of the system. This will provide numerous drawbacks to advance our understanding of unrest as well as for a better appraisal of conditions that can be encountered during geothermal exploration. In addition it will suggest technical choices of interest for geothermal companies in Guadeloupe , such as ORMAT.

In conclusion, the student will 1) gain important analytical skills (field sampling, lab analysis and the new VMS technique), 2) identify new reliable precursors of volcanic unrest, 3) know how to do geochemical modelling of aqueous solutions, compute fluid-mineral equilibria and how to use these for the geothermal exploration of a complex hydrothermal system, 4) know how to use numerical techniques about the fluid-dynamics of hydrothermal system and their response to natural and anthropic forcing agents. This PhD thesis will be co-advised by Tobias Fischer, Professor at University of New Mexico

This thesis provides a unique framework for transferring the tools developed in the academic world to applied research and society



Description de l'équipe d'encadrement principale (2 pages maximum)

The *Institut de Physique du Globe de Paris* (IPGP) has the status of EPSCP constituted in the form of a large establishment under the supervision of MESRI. IPGP is one of the very few institutions in the world that covers all disciplines of solid Earth sciences in the broad sense and which conducts studies at all time and space scales. Created in 1924 in the form of an institute of the University of Paris, then of the Pierre and Marie Curie University, the IPGP is a large establishment in its own right since 1990. The IPGP brings together more than 500 people: researchers recruited from all over the world, technologists, technicians, administrative staff, postdoctoral fellows and PhD students from all countries. The IPGP has numerous cooperation agreements with prestigious foreign institutions, making it possible to have ongoing scientific exchanges all across the world.

At the IPGP. Chemistry, physics, geology and mathematics are used to analyze and understand how our planet works and evolves and sixteen teams bring together researchers and technologists around a central discipline and experimental facilities. In addition to its location in Paris, the IPGP is also present on other sites: the volcanological and seismological observatory of Guadeloupe in Gouibeyre; the Martinique volcanological and seismological observatory in Fonds-Saint-Denis; the Piton de la Fournaise volcanological observatory located on the Plaine des Cafres au Tampon in Reunion; the national magnetic observatory at Chambon-la-Forêt in the Orléans forest in the Loiret department; The Saint-Maur-des-Fossés seismological observatory in the Val-de-Marne department.

The research carried out by the Volcanology team, one of the 16 IPGP research teams, is grouped around three main themes and in constant interaction with the volcanological and seismological observatories of the IPGP:

- Long-term evolution of volcanic systems
- Magmatic degassing and eruptive processes
- Hazards, volcanic risks and environmental impacts

These themes concern both the volcanic systems of the subduction zone (arc of the Lesser Antilles, Central America, South America, Italy) and the volcanism of "Point Chaud" (Réunion, Comoros) and of extension (Nyiragongo, DR Congo), with priority over the 3 French volcanoes (Soufrière de Guadeloupe, Montagne Pelée in Martinique, Piton de la Fournaise in Réunion), for which the IPGP is responsible for monitoring

The composition of the team (geologists, geochemists, geophysicists) brings together IPGP researchers (based in Paris and in volcanological and seismological observatories) and also researchers from the GéoSciences Réunion Laboratory of the University of Reunion integrated into the IPGP's Volcanology team. They all provide the multidisciplinary approach essential to deal with these themes, by combining field approaches, observatory monitoring, measurements and sample studies, as well as theoretical, numerical or experimental process modelling.

The Volcanological and Seismological Observatory of Guadeloupe (OVSG), established since 1950, is one of three IPGP volcanological observatories that monitor telluric hazards and carry out their own research in collaboration with teams from all countries. OVSG is a small multipurpose structure which depends on the Institute of Physics of the Globe of Paris (IPGP). The missions entrusted to the Guadeloupe Observatory include the study of the volcanic activity of La Soufrière de Guadeloupe through the recording of time series of quality geophysical and geochemical data with the aim of understanding 1) how the volcano works; 2) detect a change in behavior and assess it in terms of eruptive potential; 3) inform the authorities responsible for the protection of people and property.



The reactivation of La Soufrière of Guadeloupe, which has accelerated after several years of slowly increasing activity is of course a major scientific issue for OVSG-IPGP, which has well documented the change observed in the volcano's regime, which in April 2018 reached its highest level since the end of the 1976-1977 eruption. This reactivation emphasises the key role played by the IPGP, being responsible for the continuous observation of the overseas French volcanoes.

The OVSG is presently composed of 16 personnel units, including 5 researchers 4 CNAP °+ 1 CNRS). The observatory Director/Scientist-in-Charge (Roberto Moretti) is also the supervisor of this PhD project and is affiliated to the IPGP Volcanology team. He joined IPGP in 2017 and is *Physicien CNAP* since 2018. He has a strong experience in geochemistry and volcanology and counts more than 3000 citations and around 70 international papers, with h-index 31 (ScholarGoogle-based).



Description de la structure d'accueil secondaire (2 pages maximum)

Key activities within the Department of Earth and Planetary Sciences at the University of New Mexico are education and the scientific investigation of the Earth, the atmosphere, the hydrosphere, other planetary bodies, and the solar system are.

The Department offers undergraduate, graduate courses and PhD programs. Research in the Department of Earth and Planetary Sciences spans the full extent of the Earth from its deep interior to the surface and atmosphere, and to other planetary bodies. The department investigates the physical, chemical, and biological processes that shape the Earth and its environment from deep time to the modern. The department is also home to a number of world class facilities, such as:

- The Analytical Geochemistry Laboratory
- Center for Rapid Environmental Assessment and Terrain Evaluation (CREATE)
- Center for Stable Isotopes
- ICP-MS Laboratory
- Mineral Physics Laboratory
- Radiogenic Isotope Lab
- Secondary Ion Mass Spectrometry Facility
- SEM & Electron Microprobe
- The TEM Laboratory
- X-Ray Diffraction Laboratory
- Volatiles Laboratory

The co-supervisor of this PhD project is the Director of the Volatiles Laboratory, Prof. Tobias P. Fischer, a world-renowned volcanologist and geochemist who works on fluids discharging from active volcanoes and hydrothermal systems. He uses stable isotopes of C, N, S, Cl, H, and O to constrain the sources of volatiles. He is involved in the measurement of diffuse degassing in tectonically active areas such as the East African Rift. Current field areas are volcanoes in the Aleutians, Central America, the East African Rift (Kenya, Tanzania, Ethiopia) and Antarctica. He is member of the steering committee of the Deep Carbon Observatory's (DCO) reservoirs and fluxes community.

He joined UNM in 2000 and is currently Professor and Director of the Volatiles Laboratory in the Department of Earth and Planetary Sciences where his team uses mass spectrometry and gas chromatography to analyze the chemistry of volatiles. Professor Fischer

Professor Fischer has published more than 100 international papers and counts more than 5000 citations (H-index 46; ScholarGoogle-based)

The Volatiles Laboratory in Earth & Planetary Sciences directed by Prof. Fischer is a research and training-focused laboratory and analytical facility. The mission of the lab is to support world-class volatiles research and monitoring. The lab and its team accomplish these goals by:

- 1) Maintaining state-of-the-art analytical instrumentation capable of measuring gas compositions and fluxes.
- 2) Providing educational support in the form of training programs and workshops with hands-on instruction for undergraduate and graduate students on how to collect, prepare, and analyze gases from a variety of settings, as well as aid in the interpretation of results.
- 3) Encourage international and cross-disciplinary exchange of ideas and techniques at UNM regarding the application of volatiles in experimental and field settings.



The Laboratory capabilities include gas chromatographs with DID and TCD analyzers and a quadrupole mass spectrometer, connected to a high vacuum sample preparation line. These allow analyzing the complete gas composition (CO_2 , CH_4 , CO , N_2 , Ar , He , H_2 , O_2) in volcanic and hydrothermal samples, air samples and samples collected in vacutainer vials from CO_2 accumulation chambers or biological microcosms. The volatile laboratory strongly interacts with the local Center for Stable Isotopes to provide stable isotope analyses

In addition, the lab maintains and deploys:

- 1) a miniDOAS instrument for SO_2 flux measurements from volcanic plumes
- 2) a CO_2 accumulation chamber for soil flux measurement, modified to allow the collection of gas samples in vacutainers for the determination of CO_2 content and carbon isotopes.
- 3) gas sampling equipment to collect and transport gas samples from high temperature fumaroles, bubbling springs and soils for chemical and isotopic analyses

The Volatile Lab at EPS-UNM is a central structure in geochemistry, volcanology and volcanic hazards. The lab implements new field instrumentation for measuring volatiles and has also a strong interest in the domain of geothermal energy and the study of global natural emissions of carbon.

Self-evaluation

Originality of the project (25%):

- The current state of the art sees volcanology more and more evolving within the framework of physical-chemistry with the aim of increasing in power and precision when one wants to make forecast of eruptive phenomena. To reduce the empiricism which still greatly characterizes this domain, it is necessary to couple a solid background in instrumental/analytical chemistry with the theoretical preparation that typically is required for experts in ore deposits, hydrogeology and especially geothermal energy, of course without neglecting basic volcanology and the knowledge of the eruptive process.
- Forecasting especially on the short- and medium-term is at same time nightmare and delight for all natural risk assessment. In case of volcanic-hydrothermal systems, it requires both instrumental implementations and physico-chemical modeling, and this phd project wants to bring together. The context offered by Guadeloupe with its Soufrière is unique, because it is a highly-monitored unrest volcano with a well-developed hydrothermal system which is also of interest for geothermal exploration and exploitation as well as for the management of water resources of the Island and his community. It is therefore a unique laboratory, in which this phd thesis could prove its vision and the efficacy of its approach. That is why we want to train a specialist who can merge theory (multiphase and multicomponent chemical exchanges in the fluid-dynamic framework of reactive transport), and the practice of field measurements by implementing a quadrupole spectrometer now under development at the volatile lab of the department of Earth and Planetary Sciences of the University of New Mexico. This program is ambitious, not only for the amount of work required, but especially because it aims to train a specialist capable of getting and managing the big picture represented by the continuum **hydrothermal regime-volcanic risk and forecast-exploration and exploitation of geothermal energy**. That is why we insist on objectives such as constraining and modelling *“the full evolution, the geothermal potential and the dynamic response of the hydrothermal system”*. We expect this phd project to have the broadest possible impact on volcanology and its scientific community, but also on civil society (volcanic surveillance and civil protection policies) and industry.

Quality of supervision (20%):

We think that of the supervisor(s) will be very evident from the evaluation phase. A CV of Roberto Moretti is attached. The distinct but complementary roles of the two hosting laboratories structures are also fairly clear, and they can be easily documented with simple Internet searches. It should be noted that in volcanology the Observatory is by definition a place that stimulates research, due to the sustained and continuous flow of data, the laboratory practice (e.g. the chemical lab), the challenge in the field and the continuous elaboration of acquired data. This is even more true for an unrest volcano such as La Soufrière de Guadeloupe

- The duty of the Observatory's director (and also Phd supervisor) is also to foster and boost coordination and cooperation in the management of activities. In addition, in the case of the OVSG in Guadeloupe, the interaction with the geothermal industries (Ormat power station in

Bouillante) and the Water Office is a source of continuous motivations and challenges and disclosing new research avenues.

- The specific skills and high level of research of the Volatile Lab and associated facilities at the EPS-UNM are widely recognized around the world, in particular thanks to the scientific fertility of its director, Prof. Fischer.

Feasibility of the thesis within three years (20%):

- the project is very ambitious and obviously innovative, because in practice it proposes to place a gas chemistry lab on the ground; This is a big dream for volcanologists since always, given the conditions hostile volcanoes. However, success in this would make definitely possible real-time geochemical tracking of the hydrothermal reservoir conditions (essentially P, T but also compositional variations due to external forcings) that currently are not feasible. Besides, real time geochemical tracking will finally allow the acquisition frequency as geophysical (seismic and geodetic) monitoring, opening unprecedented perspectives to research and understanding of volcanic phenomena.
- Nevertheless, the ambition of the project resides particularly in the coupling of these new high-frequency measurements with the modeling of the whole hydrothermal system, in order to reconstruct its dynamic response to any forcing, especially of deep nature, via physico-chemical modeling of multiphase and multicomponent exchanges.
- This is then a project for a phd thesis which wants to take the "big picture" of a volcanic-hydrothermal system from an exceptional natural laboratory (La Soufrière de Guadeloupe) and export such a high-resolution big picture all over the world. All the instrumental and analytical issues will be performed at the OVSG and EPS-UNM chemical laboratories. IPGP labs in Paris will be also involved wherever necessary, based on the many ongoing collaborations

"3i" implementation

- The proposed phd argument and program are based on a strong international projection, particularly shown by the development phase at the EPS department of the UNM under the supervision of Prof. Fischer. This aspect and the planned use on the Soufrière de Guadeloupe will have a global impact which will irradiate the results of the thesis work. Andesitic (i.e. explosive) volcanism is in fact one of most serious natural threat for population on Earth, and La Soufrière of the Guadeloupe and its hydrothermal system are archetype of this kind of volcanism
- The interdisciplinary aspects are clear, and include basic volcanology, volcanic risk and its forecast, water chemistry, geothermal energy and also instrumental development optimized for hostile and harsh environments.
- I believe that the quality of supervision and local training can be well assessed and judged in relation to all the information given and also available on the Internet. I am enclosing an email with T. Fischer, with whom I spoke personally to the recent AGU in San Francisco (December 2019) while waiting to know whether to join a more formalized agreement

Curriculum Vitae

Roberto Moretti^{1,2} (Physicien CNAP; Géochimiste et Volcanologue)

¹Université de Paris, Institut de Physique du Globe de Paris, « équipe Systèmes Volcaniques »

²Observatoire Volcanologique et Sismologique de Guadeloupe, Gourbeyre (F).

Né le 6 mai 1972 à La Spezia (I); Légalement séparé ; 1 fille

Scopus Author ID: 7102753276

ORCID Author ID: <http://orcid.org/0000-0003-2031-5192>

Google Scholar: <https://scholar.google.it/citations?user=zRJWgccAAAJ&hl=it&oi=ao>

Researchgate: https://www.researchgate.net/profile/Roberto_Moretti6

CURSUS

depuis 1/9/2018 : Physicien (CNAP)

depuis 1/1/2018 : Directeur et responsable scientifique OVSG

1/11/2017 – 1/9/2018 : Physicien détaché à l'IPGP

28/1/2011 – 1/11/2017 : « Professore Universitario Associato », Università della Campania *L. Vanvitelli*, Caserta (I)

1/6/2000 – 28/1/2011: « Ricercatore Geofisico », Osservatorio Vesuviano, INGV, Napoli (I) [nommé avant obtention du PhD]

FORMATION

Avril 2002: Doctorat de Recherche (PhD) in Sciences de la Terre (course de 4 ans, prolongé à 5), Università di Pisa (I)

March 1996: « Laurea Vecchio Ordinamento » (M.Sc/Thèse 3^{ème} cycle) en Science Géologiques avec 110/110 cum Laude

Depuis Février 2018 je détiens la Qualification n. 18135199928 à Professeur des Universités, secteur 35

Depuis Février 2014 je détiens l'Habilitation nationale Italienne pour le poste de « Professore Ordinario » (Full Prof./PrI-PrCE)

N.B.: dispensé de l'HDR venant d'un autre statut

AUTRES POSITIONS ET SEJOURS INVITES

2011- 2015 Chercheur associé à l'*Osservatorio Vesuviano*, INGV, Naples (Italy)

2013-2016 Adjunct Professor au *Department of Geology* de la *St. Mary's University* (Halifax, CA).

2008 Chercheur Invité, Institut de Physique du Globe de Paris (2 mois)

2010 Chercheur Invité, Institut de Physique du Globe de Paris (2 mois)

2012 Chercheur Invité, Institut de Physique du Globe de Paris (2 mois)

2014 Professeur Invité, Institut de Physique du Globe de Paris (1 mois)

2016 Professeur Invité, Université Paris VII "Denis Diderot" (1 mois)

2017 Professeur Invité, Institut de Physique du Globe de Paris (2 mois)

PRIX

1999 Prix 'Giuseppe Schiavinato' pour la Minéralogie de l'*Accademia Nazionale dei Lincei* (l'Académie d'Italie), Rome.

Cérémonie d'attribution à la présence du Président de la République Italienne, M. le Prof. C.A. Ciampi.

AUTRES EXPERIENCES

1997: Logging Engineer, Wireline Division for Schlumberger (Gabon, Egypt, Congo français)

RESPONSABILITES COLLECTIVES

Depuis jan. 2018: Directeur et Resp. scientifique de l'Obs. Volcanologique et Sismologique de Guadeloupe/IPGP

Depuis 2018: Membre du Conseil Départemental de Sécurité Civil de la Guadeloupe (arrêté n. 2015-93 du préfet)

Depuis oct. 2018 : Membre de la Commission Administrative de suivi du PER Géothermie(arrêté DEAL 22/10/2018)

2013-2017: Membre par mérite du conseil de l'école doctorale de "Design, Innovation et Environnement", du « Dipartimento di Ingegneria Civile, Design, Edilizia e Ambiente » de l'Università della Campania *L. Vanvitelli*.

2013-2016: Membre du Gouvernement du « Dipartimento di Ingegneria Civile, Design, Edilizia e Ambiente » de l'Università della Campania *L. Vanvitelli*.

2005-2009: Membre du Comité Technique de l'Autorité de Bassin en droite Sele (décret du Président de la Région Campania, I)

EXPERTISE SCIENTIFIQUE

Depuis 2019 : Membre du Comité Pilotage du projet INTERREG PREST (porteur : OVSM-IPGP)

Depuis 2019 : Membre du Comité Pilotage « Sismik », DEAL

Depuis 2019 : Membre du Comité de Pilotage de l'Office de l'Eau de Guadeloupe

Depuis 2018 : Membre du Comité de Pilotage Paré to Paré, Croix Rouge

Depuis 2018 : Membre du Comité de Pilotage de la Fête de la Science

Depuis 2018 : Membre du Comité scientifique de Gestion de Crise pour la Soufrière de Guadeloupe

2018 : Expertise pour DEAL concernant le PER pour gites géothermiques dit « Vieux Habitants »

2013: Expertise pour ANVUR (*Agenzia Nazionale per la Valutazione Universitaria e della Ricerca*) pour les finalités de la VQR 2004-2010

2016: Expertise pour ANVUR (*Agenzia Nazionale per la Valutazione Universitaria e della Ricerca*) pour les finalités de la VQR (qualité de la recherche publique) 2011-2015

2013: Expertise pour ANVUR pour les finalités de la VQR 2004-2010
2014: Membre du Comité Scientifique et de Coordination du Projet de Haute Formation Universitaire "Experts dans le domaine des méthodes innovantes de récupérations des sols contaminés ", DICDEA-SUN
2007-2015: Conseiller de la Société Italienne de Géochimie (SOGEI)
2007 – 2011: Program Chair de European Geosciences Union (EGU), comme *Officer for Geochemistry* de la division Geochemistry-Mineralogy-Petrology-Volcanology (GMPV)

2011 Membre de commission de concours pour une position post-doc, *Univ. della Campania L. Vanvitelli*, Italie
2011 Membre de la commission de concours pour une position de chercheur CDD, *Osservatorio Vesuviano*, INGV
Plusieurs fois member de commission de concours pour post-doc, bourses d'étude et contrats de prestation à l'*Osservatorio Vesuviano-INGV* entre 2000 et 2011

2015 Rapporteur dans le Jury de Thèse de Isabelle Tannou (Doctorat Sciences de la Terre, Institut de Physique du Globe, Paris-Sorbonne Cité)
2013 Examineur dans le Jury de Thèse de Charles Le Losq (Doctorat Sciences de la Terre, Institut de Physique du Globe, Paris-Sorbonne Cité)
2011 Membre du Jury de sélection au concours d'admission au doctorat de recherché (XXV cycle) en Sciences de la Terre – Géochimie, Université de Palerme.
2008 'Examineur' dans le Jury de Thèse de Priscille Lesne (Doctorat Sciences de l'Univers, Université d'Orléans)
Membre des "comités de pilotage de Thèse" de Géraldine Zdanowicz (IPGP, Univ.Paris VII) et Charles Le Losq (IPGP, Univ.Paris VII).

ORGANISATION D'ÉVÉNEMENTS SCIENTIFIQUES

-*Exploratory Workshop* of the European Science Foundation (ESF) and INGV "Gases in Magmatic Evolution: from depth to atmosphere, from micro to macro-scale, from calculation to observation", Rome (11-13-May, 2003).
-EU-RTN Short Course "The role of volatiles in volcanic processes" (INGV-Naples, Janvier 2004), in the frame of EU *Research Training Network Programme* "Volcano Dynamics in relation to monitoring, hazard mitigation and volcano crisis response")
-Membre de l'*International Scientific Committee* of the Goldschmidt 2012, Montreal(CA) et coordinateur du Theme 4: "Ocean Ridge and Intraplate Volcanism: deep mantle supply, tectonic-magmatic processes, and ore deposits through time"
-coordinateur du Theme 8 (avec Daniel Neuville): "Melts, and Magmas glasses: from properties to processes", Goldschmidt 2013 (Florence, 25-30 Août 2013).
-Organisateur avec D.B. Dingwell et P. Richet du 8th Silicate Melt Workshop (1-5 Octobre 2007), La Petite Pierre (Strasbourg, France).
-Délégué de SoGeI (Société Italienne de Géochimie) pour l'organisation de la conférence Goldschmidt in Florence (2013) et membre du comité d'organisation local.
-Membre du comité scientifique de la conférence conjointe SGI-SIMP (*Società Geologica Italiana –Società Italiana di Mineralogia e Petrologia*), Milan, Septembre 2014.
-Membre du comité scientifique du Caribbean Science and Innovation Meeting, Le Gosier, 19-22 Octobre 2019
-Conveneur de plusieurs sessions à EGU, Goldschmidt, AGU et cetera. On cite juste les suivantes:
Session 07k (Moretti, Neuville) "Linking the Redox State of Silicate Melts to Magmatic Processes", Paris, Goldschmidt 2017, 13-18 août 2017.
Session (Moretti, Nicklas, Planavsky, Aulbach) "Oxygen fugacity and redox mechanisms in high- to low-temperature geochemical processes", 2019 AGU Fall Meeting, 7-13 Décembre 2019, San Francisco

ACTIVITÉ EDITORIALE

2019 (en cours de finalisations): numéro de ELEMENTS sur « The redox engine of Earth », édité par MR Cicconi, R Moretti et D Neuville ; prévu en 2020
2019 (en cours de finalisation) : AGU Geophysical Monograph «Magmatic redox geochemistry », édité par R Moretti et D Neuville
2009 – 2014: Topical Editor de Solid Earth, open access journal de European Geosciences Union (EGU).
2008 – 2017: Editorial Advisory Board of Chemical Geology.
2013 – 2014: Associate editor de American Mineralogist pour la glass/magma/inclusions issues
Guest Editor (avec M.R. Carroll, P. Papale, C. Textor et P. Allard) du volume de Annals of Geophysics "Gases in Magmatic Evolution: from depth to atmosphere, from micro- to macroscale, from observation to calculation", (2005) vol. 48/4-5.
Guest Editor avec P. Richet et J.F. Stebbins du volume de Chemical Geology "Physics, chemistry and rheology of silicate liquids, glasses and multiphase magmas", (2006) 229/1-3.
Guest Editor avec D.B. Dingwell et P. Richet du volume de Chemical Geology "8th Silicate Melt Workshop", (2008) vol. 56/3-4.
Reviewer pour un grand nombre de journaux internationaux (Nature Geoscience, EPSL, GCA, Chemical Geology, G³, JVGR, JGR etc...)

PROJETS SCIENTIFIQUES ET CONTRATS DE RECHERCHE

Coordinateur/porteur/responsable:

2019 : Contrat de Convergence 2019-2022 : « Système de détection dilatométrique en forage pour la surveillance de l'activité volcanique de La Soufrière de Guadeloupe ». En attente de réponse.
2019 : Responsable du projet AAP Post-Doc PO FEDER « Evaluation of the Eruptive Potential of La Soufriere de Guadeloupe: A Study of Subsurface Mechanisms and Forecasting Implications (EPLS) », (approuvé, demande d'aide financier en cours ; contribution IPGP au 20%), finalisé à un post-doc en sismologie depuis 2020.

2019 : Co-responsable (avec S. Moune) du WP1 « Emissions volcaniques » du projet PO-FEDER « IMpactMulti-Environnemental des Retombées volcaniques et sahariennes en Guadeloupe » (IMMERGE ; PI : C. Dessert), qui commencera en janvier 2020;

2018: Porteur de l'Appel Offre IPGP-2018. Titre « Depth to surface propagation of fluid-related anomalies at La Soufrière de Guadeloupe volcano (FWI): timing and implications for volcanic unrest »

2016: contrat de recherche INGV Napoli - DICDEA pour “geothermal simulations finalized to geothermal exploitation at Campi Flegrei ».

2015 : contrat de recherche INGV Napoli -DICDEA pour “reappraisal of geochemical and geophysical data at Campi Flegrei”

2013 : *local coordinator* du FP7 “Mediterranean Supersite Volcanoes” (MED-SUV), AMRA S.c.a.r.l. (ancien Centre de de la Région Campania), impliqué dans les WP3, WP4 et WP6). En 2014 J'ai dû démissionner à cause d'un grave problème chirurgical et de ses inconvénients.

2011-2013: PRIN (analogue de l'ANR), année 2009, sur “endogenous CO₂-dominated gases and their role on the magmatic process”. Responsable d'une de deux unités de recherche.

2008-2010: PRIN, année 2007, sur “thermodynamics of magmatic degassing”. Responsable d'une des trois unités de recherche

2005-2007: convention INGV-Dipartimento Protezione Civile, projet “V3_6 Etna”. Responsable d'unité de recherche et coordinateur du Task 2 “Physical and chemical properties of magma and volcanic rocks” (4 URs)

2005: LR5 *Regione Campania*, année 2002, sur « mixing properties and viscosity of silicate melts”. Seule Unité de recherché

2003: European Science Foundation (ESF), “Gases in Magmatic Evolution: from depth to atmosphere, from micro to macro-scale, from calculation to observation”, finalisé à la construction d'un *Exploratory Workshop*

Participant à plusieurs projets de recherché depuis 1997. Je cite ici le FP7 VUELCO sur l'*unrest* volcanique (2010-2013 ; coord. Univ. Bristol), le *networking* EUROVOLC (en cours) et l'InterReg PREST (en cours)

ENSEIGNEMENT ET ENCADREMENT DOCTORAL

- Master 2 et Licence en Italie (Genie Civile et Mathématique, Univ. Campania *L. Vanvitelli*) de 2011 à 2017 : physique moderne, principes de géologie et géologie environnementale.
- Co-encadrement de 2 Thèses

PUBLICATIONS ET BILIOMETRIE

Scopus: 2547 total citations (by 1581 documents), h-index: 29 | GoogleScholar: 3157 total citations, h Index: 31 | ResearchGate: 2492 total citations, h-index: 29, RGscore 33.99

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- P55) MORETTI, R., Troise, C., Sarno, F., & De Natale, G. (2018b). Caldera unrest driven by CO₂-induced drying of the deep hydrothermal system. *Scientific reports*, 8(1), 8309.
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CONFERENCES

J'ai présenté plus de 100 résumés pour des conférences internationales, congrès, écoles thématiques et workshops. Ici je cite les contributions invités et celle présentées depuis 2017, année de mon arrive à l'IPGP

Conférences invitées

- MORETTI R.(2005). *On the behavior of redox pairs in hydrous and anhydrous silicate melts: from the oxygen electrode to the mutual interactions of Fe and S*. Eos Trans. AGU, 86(52), Fall Meet. Suppl., Abstract : V23B-03 INVITED ORAL
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- MORETTI R. (2009) *Volcanic degassing*, 2009 CAMGEO School (Lucca, Italy)
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- MORETTI R. (2013) *Introductory Lecture on Redox*, Atelier "Rédox", USTV/CNRS-GDR Verres. Nancy, 21-22 mars 2013
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- MORETTI R. (2015) *Magmatic degassing*, Ecole Thématique "Verres", CNRS-GDR/USTV/IPGP, Résidence CNRS Frejus-St.Rapahael Avril 2015.
- MORETTI R (2018) *Redox (and acid-base) properties of aluminosilicate melts: the ionic-polymeric description* 15th International Conference on the Physics of Non-Crystalline Solids & 14th European Society of Glass Conference (PNCS ESG 2018), St. Malo, 9-13 Juillet 2018
- MORETTI R. (2019) *Thermochemistry of magmatic degassing* School on glass thermodynamics, TC3 ICG, GDR Thermo-HT, USTV, DGG; 12 May 2019, Friedrich Alexander University, Erlangen (D)

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A mentionner aussi les nombreux rapports de surveillance volcanique comme chercheur de l'INGV-Osservatorio mais surtout depuis mon intégration à l'IPGP comme Directeur de l'OVSG : Rapports d'activités pour le Comité de Liaison OVSG-CG971 (année 2017 et 2018), les bilans annuels OVSG (année 2017 et 2018), les bulletins mensuels OVSG d'activité tellurique (depuis 1/2018, avec format renouvelés depuis 4/18) et une myriade de communiqués de séismes ressentis



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January 7, 2020

Dear Dr. Moretti,

This letter is to express my full and strong support for the Ph.D. project that you outline in your proposal. The topic to investigate the dynamic processes in the hydrothermal system of Guadeloupe using gas geochemistry is timely in that it will provide new quantitative information related to eruption precursors and geothermal exploration. The combination of the analytical results with high-level modeling using TOUGH2 is novel and promising.

From my side, I am happy to contribute analyses of gas samples in my laboratory and using the Volcano Mass Spectrometer, recently developed in collaboration with Dr. McMurtry, University of Hawaii (McMurtry, G., L. Dasilveira, K. Falinski, and T. P. Fischer (2019), VGAM: Compact and Low Power Mass Spectrometer-based Instrumentation for Volcanic Gas Monitoring. *Geochem. Geophys. Geosys.*, 20(7), 3782-3798). As we have discussed at Fall AGU, the VGAM still needs additional work, calibration and testing. The selected Ph.D. student is welcome to work in my laboratory on this project. We have excellent facilities for gas analyses and calibration of instruments that the student is free to use during her or his stay. In addition, and if time and resources permit, I will be glad to participate in field campaigns. Additionally, I will work with you and the student on data interpretation and publication of the results.

Good luck with the proposal and I am looking forward to collaborate in the near future.

Best regards,

Dr. Tobias Fischer
Professor
Department of Earth and Planetary Sciences
The University of New Mexico