

## PHD PROPOSAL FOR THE DOCTORAL SCHOOL « Ecologie, Géosciences, Agronomie, ALimentation »

### GENERAL INFORMATION

<b>Thesis title: Geochemical behaviors of multivalent elements during the genesis and evolution of magmas: implications for the redox state of the Earth's mantle</b>
<b>Acronym:</b> EC2GEM
<b>Disciplinary field 1:</b> Geosciences <b>Disciplinary field 2:</b> Select an element
<b>Three keywords:</b> volcanism, oxygen fugacity, geochemistry
<b>Research unit :</b> LPG
<b>Name of the thesis director HDR (Habilitation thesis to supervise research) required:</b> Bézos, Antoine <b>Email address of the thesis director:</b> antoine.bezos@univ-nantes.fr <b>Name of the thesis co-director (if applicable): HDR (Habilitation thesis to supervise research) required:</b> <b>Email address of the thesis co-director (if applicable):</b> <b>Name of the thesis co-supervisor 1 (if applicable):</b> Frenandez, Vincent <b>Email address of the thesis co-supervisor 1 (if applicable):</b> Vincent.Fernandez@cnrs-immn.fr <b>Name of the thesis co-supervisor 2 (if applicable):</b> <b>Email address of the thesis co-supervisor 2 (if applicable):</b>
<b>Thesis grant (funding origin and amount):</b> : allocation de recherche de l'université de Nantes 75% Fonds propres du laboratoire 25%
<b>Contact(s) (mailing address and E-mail):</b> Université de Nantes, 1, quai de Tourville BP 13522 44035 Nantes Cedex 1
<b>Recruitment process:</b> Recruitment process depends on thesis funding. To select the corresponding recruitment process, please visit the EGAAL website <a href="#">here</a> . This information is needed for proposal publication. <input checked="" type="checkbox"/> <b>Doctoral school contest</b> <input type="checkbox"/> <b>Interview</b> <input type="checkbox"/> <b>Other (indicate) :</b>

**All sections must be filled. Once filled, please save the proposal form in pdf format using the following naming: Supervisor Name\_Unit\_Subject Acronym\_EN.pdf**

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## SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

### **Socio-economic and scientific context : (10 lines)**

The oxidation state of the mantle is one of the major parameters controlling the physicochemical evolution of the Earth. It is commonly estimated from the study of mantle derived melts and expressed in terms of oxygen fugacity ( $fO_2$ ), an intensive thermodynamic variable. The mantle  $fO_2$  controls the valence state of the elements sensitive to redox conditions and by incidence, their geochemical behaviors during the genesis and evolution of magmas (partition coefficients, solubility, volatility). Thus, many oxybarometers have been developed to determine the  $fO_2$  of magmas from measurements of valences, concentrations or isotopic compositions of elements sensitive to redox conditions (Fe, V, S, etc.). The prevailing view is that  $fO_2$  variations measured in arc, hotspot and oceanic ridge lavas are directly inherited from the redox state of their sources. However, contradictory results for some of these oxybarometers tend to question the postulate of redox equilibrium between magmas and their sources — leaving therefore the main role to magmatic differentiation processes.

### **Assumptions and questions (8 lines)**

This thesis aims to constrain the redox geodynamics of the Earth's mantle, based on a "multi-tool" study of magmas  $fO_2$  coupled with the modeling of redox equilibria between magmas and their sources. All sample collections will be carefully selected to explore the dominant magmatic processes of each geodynamic contexts. The redox equilibrium between magmas and their sources will be discussed on the basis of the geochemical data acquired and the quantitative models developed by the PhD student.

### **The main steps of the thesis and scientific procedure (10-12 lines)**

This "multi-tools" geochemical approach will be first applied to magmatic glassy samples, then to rocky samples in order to extend their application fields to actual and ancient crystalline rocks.. Finally, a partial melting model taking into account the  $fO_2$  and the partitioning of multivalent elements between solid and liquid phases will be developed.

### **Methodological and technical approaches considered (4-6 lines)**

Since iron is the only major element having several valence states in mantle derived melts, a particular attention will be paid to it. We will use the X-ray photoelectron spectroscopy (XPS) to develop an innovative method of the analysis of the iron oxidation state in magmatic glasses and minerals. In conjunction with this analytical work, similar analyses will be performed by wet chemistry and XANES spectroscopy. The geochemical analyses of trace elements sensitive to redox conditions (V, S, Cr, Cu, etc.) will be performed by ICP-AES, ICP-MS, LA-ICP-MS and, if necessary, by MC-ICP-MS for isotopic analyses (Fe, V).

### **Scientific and technical skills required by the candidate**

Mobilization of concepts in petrology, geochemistry  
Implementation of experimental approaches  
Collection, interpretation and modeling of experimental data  
Use and understanding of written and oral expression in English  
Ability to synthesize data (reports and oral communications)  
Ability to work independently, in groups, with rigor and method

## THESIS SUPERVISION<sup>1</sup>

<b>Unit name:</b> LPG UMR CNRS 6112 – Université de Nantes – Université Angers	<b>Team name:</b> Planète Terre
<b>Unit director name:</b> Antoine Mocquet	<b>Team director name:</b> Eric Beucler/Olivier Bourgeois
<b>Mailing address of the unit director:</b> antoine.mocquet@univ-nantes.fr	<b>Mailing address of the team director:</b> eric.beucler@univ-nantes.fr/olivier.bourgeois@univ-nantes.fr
<b>Thesis director</b> Surname, first name: Bézos, Antoine Position: Assistant professor Obtained date of the HDR (Habilitation thesis to supervise research):25/09/2017 Employer: Université de Nantes Doctoral school affiliation: EGAAL Rate of thesis supervision in the present project (%): 70% Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 0% Number of current thesis supervisions/co-supervisions: none	
<b>Thesis co-director</b> Surname, first name: Position: Obtained date of the HDR (Habilitation thesis to supervise research): Employer: Doctoral school affiliation: Rate of thesis supervision in the present project (%): Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): Number of current thesis supervisions/co-supervisions:	
<b>Thesis co-supervisor 1 (if applicable)</b> Surname, first name:Fernandez, Vincent Position: IR	

<sup>1</sup> In EGAAL Doctoral School, if only one scientist in thesis supervision = 100% of supervision rate; if 2 people involved in thesis supervision = from 50% to 70% of supervision rate for the director; if 3 people involved in thesis supervision = 40% / 30% / 30% of supervision rate distribution among supervisors.

Habilitation thesis to supervise research  yes  no If yes, date diploma received:

Employer: Université de Nantes

Doctoral school affiliation: Matière Molécules Matériaux

Rate of thesis supervision in the present project (%): 30%

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 0%

Number of current thesis supervisions/co-supervisions: none

**Thesis co-supervisor 2 (if applicable)**

Surname, first name:

Position:

Habilitation thesis to supervise research  yes  no If yes, date diploma received:

Employer:

Doctoral school affiliation:

Rate of thesis supervision in the present project (%):

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):

Number of current thesis supervisions/co-supervisions:

**Private partner (if CIFRE funding, private funding,...)**

Surname, first name:

Position:

Employer:

Rate of thesis supervision in the present project (%):

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):

Number of current thesis supervisions/co-supervisions:

**International partner (if Cotutelle thesis)**

Surname, first name:

Position:

Employer:

Rate of thesis supervision in the present project (%):

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):

Number of current thesis supervisions/co-supervisions:

**Professional status of previous PhD students supervised by both director and co-supervisors (from 5 years)**

*Please provide the following information for each PhD students supervised*

Surname, first name: Petersen, Jassin

Date of PhD beginning and PhD defence: 11/2013 – 02/2017

Thesis supervision: Antoine Bézos co-supervisor

Professional status and location: researcher, Germany

Contract profile (post-doc, fixed-term, permanent): post-doc

List of publications from the thesis work:

Petersen J., Barras C., **Bézos A.**, La, C., De Nooijer L. J., Meysman F. J. R., Mouret A., Slomp C. P., & Jorissen F., (2018). Mn/Ca intra-test variability in the benthic foraminifer *Ammonia tepida*, *Biogeosciences*, 15, 1-18.

Petersen J., Barras C., **Bézos A.**, La C., Slomp C. P., Meysman F. J. R., Mouret A., Jorissen F.J., (2019). Mn/Ca ratios of *Ammonia Tepida* as a proxy for seasonal coastal hypoxia, *Chemical Geology*, 518, 55-66.

**Publications majeures des 5 dernières années du directeur de thèse et co-directeur(s)/co-encadrant(s) sur le sujet de thèse :**

**Bézos A.**, Guivel C., La C., Fougeroux T., Humler E. (2021). Unraveling the confusion over the oxidation state in MORB glasses, *Geochim. Cosmochim. Acta*, DOI: 10.1016/j.gca.2020.10.004.

Larre C., Morizet Y., **Bézos A.**, Guivel C., La C., Mangold N., (2019). Particular H<sub>2</sub>O dissolution mechanism in iron-rich melt : Application to Martian basaltic melt genesis, *Journal of Raman Spectrometry*, DOI: 10.1002/jrs.5787.

Escartin, J., Mevel, C., Petersen S., Bonnemaïn D., Cannat M., Andreani M., Augustin N., **Bézos, A.**, Chavagnac V., Choi Y., Godard M., Haaga K., Hamelin C., Ildefonse B., Jameison J., John B., Leleu T., MacLeod C. J., Massot-Campos M., Nomiou P., Olive J. A., Paquet M., Rommevaux C. Rothenbeck M., Steinfuhrer A., Tominago M., Triebe L., Campos R., Gracias N. & Garcia R., (2017). Tectonic structure, evolution, and the nature of oceanic core complexes and their detachment fault zones (13°20'N and 13°30'N, Mid Atlantic Ridge), *GGG*, 18, doi : 10.1002/2016GC006775.

Petersen J., Barras C., **Bézos A.**, La, C., De Nooijer L. J., Meysman F. J. R., Mouret A., Slomp C. P., & Jorissen F., (2018). Mn/Ca intra-test variability in the benthic foraminifer *Ammonia tepida*, *Biogeosciences*, 15, 1-18.

**Fernandez V.**; Fairley N.; Baltrusaitis J (2021), Unraveling spectral shapes of adventitious carbon on gold using a time-resolved high-resolution X-ray photoelectron spectroscopy and principal component analysis. *Applied Surface Science* Volume 538, 2021, 148031 DOI: 10.1016/J.APSUSC.2020.148031

George H., Fairley N., Sherwood P., Linford M., Terry J., **Fernandez V.**, and Artyushkova K. (2020). Practical guide for curve fitting in x-ray photoelectron spectroscopy. *Journal of Vacuum Science & Technology A* 38, 061203 <https://doi.org/10.1116/6.0000377>

Clavier B., Baptiste T., Massuveau F., Jouanneaux A., Guiet A., Boucher F., **Fernandez V.**, Rogues C., Corbel G.

Enhanced bactericidal activity of brucite through partial copper substitution

*J.Mater.Chem.B*, 2020, 8, 100 DOI: 10.1039/C9TB01927H

Fernandez V., Kiani D., Fairley N., Felpin F.X., Baltrusaitis J. (2020). Curve fitting complex X-ray photoelectron spectra of graphite-supported copper nanoparticles using informed line shapes. *Applied Surface Science* Volume 505, 1 March 2020, 143841 [doi.org/10.1016/J.APSUSC.2019.143841](https://doi.org/10.1016/J.APSUSC.2019.143841)

Mercier N., Leblanc A., Allain M., Dittmer J., Fernandez V., Pauporté T.

Lead- and iodide-deficient (CH<sub>3</sub>NH<sub>3</sub>)PbI<sub>3</sub> (d-MAPI): the bridge between 2D and 3D hybrid perovskites

*Angewandte Chemie International Edition*: 2017, 56, 16067 – 16072 DOI: 10.1002/anie.201710021

## THESIS FUNDING

<b>Origin(s) of the thesis funding:</b> Allocation de recherche de l'université de Nantes 75% Fonds propres du laboratoire 25%
<b>Gross monthly salary: according to the salary grids in force</b>
<b>Thesis funding state : Partly acquired (co-funding)</b>
<b>Funding beginning date/Funding ending date: 15/09/2021 -15/09/2024</b>

**Date: March 25<sup>th</sup> 2021**

**Name, signature of unit director: Antoine Mocquet**



**Name, signature of team director: Éric Beucler**



**Name, signature of thesis project director: Bézos, Antoine**

